PRIMER OF PHYSIOLOGY AND HYGIENE

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PRIMER

OF

PHYSIOLOGY

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HYGIENE

A TEXT-BOOK FOR PRIMARY CLASSES, WITH SPECIAL REFERENCE TO THE EFFECTS OF STIMULANTS AND NARCOTICS ON THE HUMAN SYSTEM

BY

WILLIAM THAYER SMITH, M.D.

AUTHOR OF "THE HUMAN BODY AND ITS HEALTH"

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PREFACE.

In studying the body, it is very desirable that the scholar should, as far as possible, see and handle the parts described. Children especially can learn much more readily in this way than from any description. A dissection of a cat or dog or rabbit, illustrating the lessons, will make the text clear, and fix the essential facts in the mind.

Or, if this can not be done, pieces of muscle and of cartilage, joints and bones, a heart, the lungs, a liver, an eye, and other organs, can be obtained from the butcher, to serve the same purpose.

The apparatus mentioned in illustration of the action of organs — the bellows, the syringe, and others that may occur to the teacher — should be shown.

Models and plates are also valuable. A few clear ideas of the structure and functions of the

body will be worth much more to the children than many details imperfectly understood.

On the subject of stimulants and narcotics, I have endeavored to make no statements which are not susceptible of positive proof, and to present only facts which children are capable of appreciating. Much more might be said which does not come within the province of such a work as this.

WILLIAM THAYER SMITH.

HANOVER, N.H., May 1, 1885.

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CHAPTER I.

INTRODUCTION.

SECT. I.—**1.** When we were very young children, we did not need to know much about our bodies. Our parents took care of them. They managed our eating and drinking and sleeping. They clothed us, and tried to keep us in good health.

As we grow older, we can take more care of ourselves. But we can not take care of our bodies properly unless we know something about them.

We need to know what they are made of; what becomes of the food we eat; what things are good to eat and drink, and what are bad; why we breathe; what the heart beats for.

All this knowledge is called **Anatomy** and **Physiology.**

2. The body is like a clock, with its wheels, and its spring, and its hands, and its ticking. If we take the clock to pieces, to see what it is made of, that is like the study of *Anatomy*. Just so the bodies of animals and men have been examined, to see what they are made of. If we set the clock a-going, and watch it to see how it ticks and strikes, and turns its hands, that is like the study of *Physiology*. Just so learned men spend a great deal of time in watching animals and men, to see how they move and eat and breathe and feel.

When we have learned these things about our bodies, we shall know how they should be taken care of in order to keep them in health. This knowledge is called **Hygiene.**

3. Many grown people are very ignorant of these things. They abuse their bodies, and wear them out in various ways. Drinking intoxicating liquors, and smoking or chewing tobacco, are among the most common ways.

QUESTIONS.

SECT. I.—**1.** What is Anatomy? Physiology?

2. What may the body be compared with? What is Hygiene?

3. Are we all acquainted with our own bodies? Mention a common way of abusing the body.

CHAPTER II.

THE BODY.

SECT. I. — **1.** When we look at the body of a man, we notice these things: —

(*1.*) It is made of several parts; namely, the **head** and **neck,** the **trunk,** the **upper limbs,** the **lower limbs.**

The upper limbs are divided into the *arm* (from shoulder to elbow), the *fore-arm* (from elbow to wrist), and the *hand.*

The lower limbs are divided into the *thigh* (from hip to knee), the *leg* (from knee to ankle), and the *foot.*

(*2.*) If we draw a line from the top of the head down on the backbone, we shall divide the body into halves, which are just alike. Each half has an eye and an ear, and an arm and a leg. True, we have but one nose and one mouth; but nose and mouth have two sides, which are alike.

(*3.*) The whole body is covered by the **skin.**

THE SKIN.

SECT. II. — **1.** The *skin* is soft and smooth and elastic. It fits perfectly, and yet is never tight, as

new clothes sometimes are. It is about one-tenth of an inch thick, and it has two layers. When we raise a blister, the top layer, called the *cuticle*, is lifted up by the water which gathers under it. When we fall, and scrape the skin off, it is generally only this same top layer that we have scraped off. The red, sore surface which is left, is the deep layer, or *cutis*. If we really scrape away the whole thickness of the skin, it is a serious injury. After a blister, the skin will heal, and look just as it did before. But, if both layers of the skin are torn or cut out, a scar will remain.

2. A *scar* is a piece which nature puts in to patch a torn skin. Like the patch on a boy's trousers, it never looks exactly like the rest of the skin. That is because it is not exactly like it. It is not real skin. One peculiarity of a scar is, that it keeps shrinking for a long time. If a child gets a deep burn on his neck, the scar will often shrink so much that it will draw his head to one side, and give him a wry neck. If the burn is under his arm, the scar may draw his arm down so that he can not raise it far from his side. On his hand, it may prevent him from straightening his fingers.

3. It is very important when a deep burn, or any other injury that takes out a part of the skin, is healing, to have it properly attended to. By

care, the scar may be kept from drawing too much.

4. *Dandruff* is from the outer layer of the skin on the head. When the scalp is dry, these little scales come off in great numbers. Just such scales, only smaller, are coming off all the time from every part of the skin. They are rubbed off with each movement that we make. But they are so fine that we do not see them. In this way the skin is continually wearing off; and, if it did not grow, it would soon be all worn away. But it grows down in the deep layer as fast as it wears off on the surface.

PERSPIRATION.

5. If you touch the face of a person sick with a fever, you will find that it is hot and dry. The skin of a well person has a different feeling. It is moist. When the air is very hot, or you have been playing hard, you can see the moisture standing in drops, or running down in streams.

We call this **perspiration,** or **sweat.** Where does it come from?

6. On the ends of your fingers, you can see that the surface of the skin is all in ridges, with furrows between. With a strong magnifying-glass, these ridges would look as they do in the figure (Fig. 1).

You would see on the ridges little holes, which are represented by the black dots in the figure. Just such little holes are in the skin all over the body. We call them **pores.** There are as many as 2,500,000 of them.

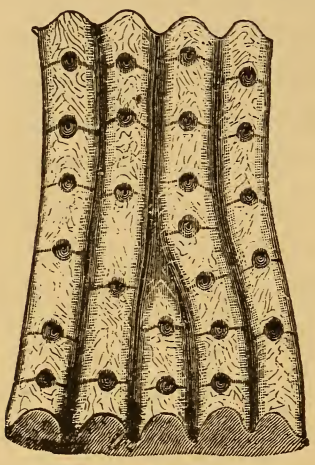

Fig. 1.

Ridges in the Skin of the Palm. The Black Spots are the Pores.

7. The pores are the mouths of little pits, or wells, which are called the **sweat-glands.**

These wells are tubes about one-fourth of an inch long, which run down nearly to the under-surface of the skin, and there end in a coil.

8. The sweat is constantly rising in these tubes, and flowing over on the surface. Ordinarily it dries off immediately, and we can not see it. When we are very warm, it comes faster than it can dry; and we feel and see it.

9. But where do these tubes get the sweat? By examining with the microscope, it has been found that the coils at the bottom of the tubes are all covered with a network of very small blood-vessels. The blood is partly water; and, as it flows through these little vessels, some of the water soaks through their walls, and through the walls

of the sweat-gland; and so these glands are continually filling, and flowing over.

The sweat-gland is like a spring in which water is always bubbling up from streams down under-ground.

Fig. 2.
Sweat-Gland, with small blood-vessels surrounding it.

10. Since each one of the tubes is about one-fourth of an inch long, and there are about 2,500,000 of them, you can easily estimate the length of the tube that would be made if they were all joined in one. More than a pint of water passes off through the pores, from the body of a man, in a day.

THE HAIR.

11. A dog or a horse has *hair* all over his skin. So has a man; but, on the most of his body, it is so short and thin that you can scarcely see it. The reason for this is plain, when we remember that man has skill and hands to clothe himself, and the dog and the horse have not. Therefore, Mother Nature, who takes good care of even her dumb children, makes the hair grow thick to keep them warm. She did not intend that men should

cover their heads as they do their bodies, for eyes and ears and nose and mouth must be kept open. So she gave us long hair on our heads to protect them in part.

Hair is beautiful as well as useful. Each hair has its root at the bottom of a tube, which runs down from the surface to the under side of the skin.

SEBACEOUS GLANDS.

12. Besides the *sweat-glands*, there are other glands in the skin, called **sebaceous glands.** They are little sacs, with a tube leading from them. They give out an oily fluid. On the face, they are rather large. Sometimes they get full of the fluid, which becomes thick, and then turns black. When these black spots are squeezed, their contents come out. They look like worms, and are often called worms.

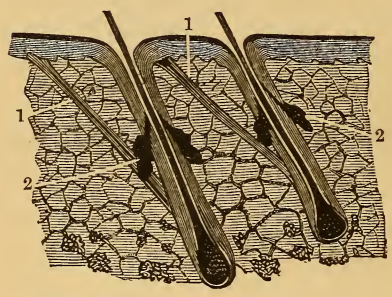

Fig. 3.

SECTION OF THE SKIN, SHOWING ROOTS OF HAIRS. — 1. Muscles attached to the hair-sac. 2. Sebaceous glands.

13. But most of the *sebaceous glands* open into the tubes from which the hairs grow. They discharge their oil about the roots of the hair. This

makes the hair soft and glossy. The oil spreads over the surface of the skin also, and helps to keep it smooth and soft. When the scalp is unhealthy, these little glands do not work, and the hair becomes dry and brittle.

THE NAILS.

14. The *nails*, like the hairs, grow out of the skin. They make the ends of the fingers firm, so that we can pick up small things, and hold them better.

15. The nails are all the time growing; and, if one is torn out, a new one will grow, provided that the red bed of skin under it, from which it grows, is not also torn away.

The habit of biting the nails ought always to be avoided. Fingers on which the nails are bitten to the quick look badly, and are less useful than others.

WHAT THE SKIN IS FOR.

16. (*1.*) The skin is a protection to the parts under it. It is elastic and tough. A strong man can sometimes split a board with his fist without breaking the skin.

We sometimes have to handle things that are poisonous. If our skin is whole, we will not be hurt. But, if we have a scratch or cut on our

hands, we should be very careful how we let any thing poisonous touch it.

(*2.*) The skin keeps the body warm.

(*3.*) The skin makes a delicate and beautiful covering.

(*4.*) The skin gives off waste matters from the body.

You remember about the sweat-glands, — how the water passes from the blood into them, and out on the surface of the body. But sweat is not all water. It contains also *salt* and other substances which the body needs to get rid of. These amount to two or three spoonfuls in a day. If the skin does not carry this off, we can not be well.

(*5.*) The skin regulates the heat of the body.

BODILY HEAT.

17. The body is a kind of walking stove, which is making heat all the time. A number of cattle together will keep a cold barn warm, and a number of people in a room will make it very hot in warm weather.

The food that we eat is the fuel, and the life in us is the fire. When the fire is out, the stove is cold. When the life is out, the body is cold. Now, the heat that is made is kept in by the skin and by the clothing.

18. But suppose we are too warm. Then the skin, instead of keeping in heat, lets it out; and it does it in this way: —

If our faces are hot, and we wet them, and let them dry in the air, it cools them. *When water dries off from any thing, it always cools it.* If we are too warm, the sweat-glands go to work actively, and the water wells up fast on the surface, and dries off. This makes us cooler; and, when we are cool enough, the sweat-glands work more slowly again.

19. Some men are foolish enough to drink whisky, when it is hot, to make them cool; and, when it is cold, they drink it to make them warm.

They might better trust to the natural action of the healthy skin, which whisky interferes with.

20. In cold weather we eat more food, and we wear thicker clothing. Clothing does not make heat, but it keeps in the heat we have. Besides that, we are obliged to keep fires burning, in order to be comfortable. We are not as independent as the animals, whose bodies can make heat enough to endure winter without fires.

21. The temperature of the blood is always about 100° Fahrenheit when we are well. It makes little difference whether the air about us is

warm or cold. In the African and the Greenlander it is the same.

When we have a fever, it is higher, and may reach 106° or 107° Fahrenheit.

CARE OF THE SKIN.

22. Since the skin has such important work to do, we ought to take good care of it. We are not likely to tear our skins, or burn them, or wear holes in them, — as we do with our clothes, — if we can help it. Nature has filled them full of delicate little nerves, which give us great pain if we do any such thing. We are pretty careful not to hurt them, or to let any one else hurt them. But we may neglect them.

23. It is bad for the skin to wear too thick clothing. It keeps it wet with perspiration, and softens and weakens it.

It is bad for the skin to stay too much in hot rooms. The skin needs fresh air to make it vigorous.

BATHING.

24. The skin should be thoroughly washed often. A daily bath is an excellent thing.

Bathing keeps the pores and the sebaceous glands open. The rubbing by which we dry it makes the blood flow through it, and makes it soft

and pliable. The cool water rouses it, and makes it active. If we bathe often, we shall not be likely to catch cold. We catch cold by getting the skin chilled by damp air or water. By bathing and rubbing, the skin becomes strong, so that it is not as easily chilled when we are in a draught, or wet our feet. People have been cured of many diseases by simply bathing and rubbing the skin. It is one of the very best ways to prevent disease.

Bathing in salt water is more refreshing than bathing in fresh water. The salt stimulates the skin.

THINGS TO BE AVOIDED.

25. When you are perspiring a good deal, do not sit down on damp ground, or in a draught of air. It may give you a cold to chill your heated skin so suddenly.

For the same reason, do not go into cold water when you are heated from play. Cool off first.

Do not bathe directly after eating.

Never stay in the water until you are chilled through. It may injure you seriously.

EFFECTS OF ALCOHOL AND NARCOTICS.

26. A clear complexion is a great beauty. Any thing that will destroy it should be avoided if possible. The use of alcoholic liquors reddens the

nose, and often mars the face with blotches and pimples.

27. Tobacco-using boys acquire a sallow, lifeless-looking skin, which represents the condition of their whole system.

QUESTIONS.

SECT. I. — **1.** What parts make up the body? Where is the thigh? the fore-arm?

How may the body be divided into parts which are just alike?

What covers the body?

SECT. II. — **1.** Describe the skin. What happens when we raise a blister? when we scrape the skin off?

2. What is a scar? What danger in a large scar?

3. What should we take pains to prevent when the skin is destroyed in any part?

4. What is dandruff? How does the skin wear off? Why does it not wear out?

5. What is perspiration?

6. What are the pores? How many of them are there?

7. Describe the sweat-glands.

8. How do the sweat-glands act?

9. Where does the sweat come from?

10. How many sweat-glands are there? How long a tube would they make if all were joined in one?

11. Why has not man as much hair as the lower animals?

What is the use of hair?

Where are the roots of the hair?

12. What is a sebaceous gland? What does it give out?

13. What have the sebaceous glands to do with the hair?

14. What do the nails grow from? What are they good for?

15. Will a nail grow again if it is torn off?

16. Uses of the skin. Name the first mentioned; the second; the third; the fourth; the fifth.

17. How is the body kept warm?

18. How is the body cooled when too warm?

19. Is whisky good to keep men warm or cold?

20. How do we keep our heat in cold weather?

21. What is the temperature of the blood? Is it the same in all men? How does it change in a fever?

22. How does Nature keep us from injuring our skins?

23. What is bad for the skin?

24. What is the effect of bathing the skin? How do we catch cold?

25. Name some things to be avoided.

26. How may the use of alcohol affect the skin?

27. How may the use of tobacco affect the skin?

CHAPTER III.

THE MUSCLES.

SECT. I. — **1.** We have taken a general view of the outside of the body, and studied its covering. We have next to examine the parts beneath.

If I ask you what we shall find if we take off the skin of an animal, you will probably answer *flesh.*

If I ask you what flesh is, you will tell me that it is a part of an animal which is red and soft and elastic, and that it is good to eat.

You perhaps do not know that this flesh, which is served up as roast beef, mutton, and other meats, is the *muscle* of the animal. While he is living, it enables him to move and work. When he is killed, it is our food.

2. If you grasp your fore-arm just below your elbow, and then double your fist tightly, you will feel your fore-arm swelling, and growing hard.

All boys know how to bend the elbow, and feel the lump rising on the front of the arm.

It is **muscle** that swells and hardens under the skin.

3. Our flesh is not all one mass of muscle, but it is made up of many muscles bound together.

Fig. 4.

Muscles of the Back.

Muscles are of different shapes. Some of them are flat, like a piece of cloth. Flat muscles are

spread out over the trunk of the body. Some of them are long and slender. The **sartorius** or tailor's muscle, which is in the thigh, is about two feet long. Some of them are shaped like a spindle full of thread. The smallest muscle in the body

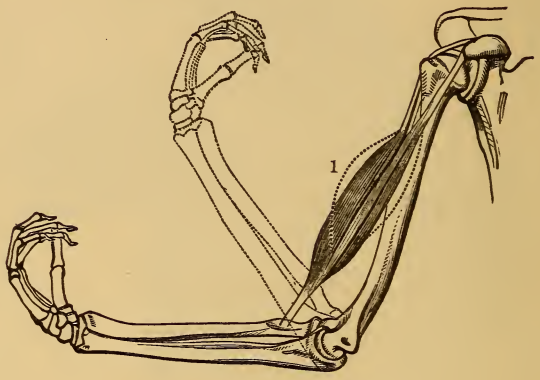

Fig. 5.

1. BICEPS MUSCLE. The dotted lines indicate the changed shape of the biceps when the fore-arm is drawn up.

is called the **stapedius**. It is in the ear, and is not more than one-sixth of an inch long.

4. Most of the muscles are attached to a bone at each end. When they swell and shorten, they draw one of these bones nearer to the other. When you lay your hand on your arm, and feel the muscle in it swell, it is drawing the fore-arm toward the shoulder. This muscle, called the **biceps**, is attached to a bone of the shoulder above, and to a bone of the fore-arm below.

It is by the muscles acting in this way that we make all our movements.

WALKING.

5. For example, let us see how we walk. Stand with your feet together. Begin slowly to walk, and see what you do. First you lean a little, so as to throw your weight on either your right or your left foot. Let it be the left this time. Then the muscles of your thigh contract, and lift your right foot from the ground, and carry it forward. All this time your weight is resting on your left foot. When you have carried your right foot far enough forward, you let it come down on the ground. Then both feet are on the ground, the right being some distance ahead of the left. Next the muscles of the calf of your left leg shorten; and that raises your left heel from the ground, and throws your whole body forward on your right foot. Then the muscles in your left thigh contract, and lift the left foot clear of the ground; and it swings forward by its own weight — like a pendulum — until it is ahead of the right foot, when it is planted on the ground. So each foot in its turn swings ahead of the other.

The muscles mentioned are not the only ones engaged in walking. A great many muscles take

part. These are the principal ones. By laying your hand on your thigh or calf, you can feel them harden as you step.

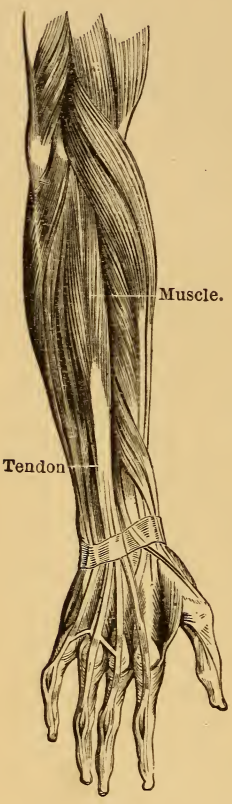

Fig. 6.
Muscles and Tendons.

TENDONS.

6. Most of the muscles have a *tendon* at one or both ends. A tendon is a strong, tough white cord or band. It may be round or flat; and it does not stretch, as muscle does. Any boy whose parents kindly let him have the drumstick when there is chicken for dinner, can find the tendons in it. They are not good to eat, but they are very good to fasten a muscle to a bone.

7. The largest tendon is the **tendon of Achilles,** the thick cord which is fastened to the heel. It is at the end of two big muscles that make the calf. You can easily find out why it is called the tendon of Achilles. The story is too long to tell here.

The tendons of the muscles of the fore-arm can be seen and felt just above the wrist.

TWO KINDS OF MUSCLE.

8. The muscles on the outside of the body contract when we will. They are called *voluntary* muscles. But there are other muscles, which do not obey our wills. They are called *involuntary* muscles. These are chiefly inside of the body. They are in the walls of the stomach and bowels and of the breathing-tubes and blood-vessels. The heart itself is made of this kind of muscle. These muscles work of themselves, without asking our permission. The Creator has made us so that we can move our bodies as we please. But the heart and other involuntary muscles he put in us to do a certain work by his direction. We can help or hinder them, but we can not control them directly by our wills.

It is much better for us that it is so. The work of the involuntary muscles is necessary for the continuance of our lives. They are like good servants that do it for us without troubling us to look after them.

HOW MUSCLE CONTRACTS.

9. We do not know *how* muscle shortens when we wish it to. We know that it does so, but we can not explain it.

EXERCISE.

SECT. II. — **1.** All parts of the body were made to be used. Prisoners grow pale and thin and weak for want of exercise. If your leg gets lame, so that you can not use it, in a little while you will find it growing softer and smaller than the other one.

2. The muscles make nearly half of the body, so they need a good deal of exercise. The plays which are natural for children are good for them. They make the muscles strong and active.

3. One reason why exercise is good for the muscles is, that it makes the blood flow faster through them. If the blood is cut off from a muscle, it gets numb, and will not work. Plenty of blood makes it grow.

4. Another reason is, that, when we exercise, we breathe fast, and get a good deal of oxygen into our blood. Such blood gives more life to the muscles.

5. If we wish to have well and active bodies, we must be willing, not only to play, but also to work, with our muscles.

EXPRESSION OF THE FACE.

6. A very important set of muscles is in the face. They are attached to the skin, and by their action give various expressions.

Those expressions which are most frequently on the face, finally become fixed there. So the face shows the state of the mind, and one who desires to have a beautiful face must be careful to keep a kind and happy temper.

THINGS TO BE AVOIDED.

7. We should not try to do things that are too hard for our strength.

Neither should we try to keep up an exercise until we are exhausted. By running, or jumping rope, too long, children may be seriously injured.

EFFECT OF ALCOHOL AND TOBACCO.

SECT. III. — **1.** The tendency of alcohol is to cause muscle to change into fat. Men who drink a good deal of it may look very large and strong when they are really weak. Their muscles are not hard, but soft and fatty.

Men who are training for a race do not use alcohol and tobacco, because they know their muscles will be weakened by them.

2. It is a fine thing for a boy or a man to have strong muscles.

He can enjoy himself, and help others better, for it. It is not a fine or a manly thing to have the sallow face, and thin legs and arms, that are

likely to belong to boys who smoke cigarettes or cigar-stumps.

QUESTIONS.

SECT. I. — **1.** What lies beneath the skin?

What is flesh?

2. What swells and hardens when we bend our elbows?

3. What shapes have muscles? Where is the longest muscle in the body? Where is the shortest?

4. What do muscles do? What are they attached to? What is the biceps muscle attached to?

5. Describe the process of walking.

6. What is a tendon? What is its use?

7. Where is the tendon of Achilles? Why is it so named?

8. What are the two kinds of muscle called?

What is the difference between them?

Where are the involuntary muscles chiefly found?

9. Do we know how muscle shortens?

SECT. II. — **1.** What happens to a muscle if we do not exercise it?

2. How much of the body is muscle?

3. Give a reason why exercise is good for the muscles.

4. Another reason.

5. What must we do to have well and active bodies?

6. What gives expression to the face?

How may we cultivate beauty of face?

7. In exercising, what caution is to be observed?

SECT. III. — **1.** What is the effect of alcohol on muscle? Do athletes in training use it?

2. Does using tobacco make a boy manly, or unmanly?

Fig. 7.
The Arterial System.

CHAPTER IV.

THE HEART AND BLOOD-VESSELS.

SECT. I. — **1.** If you cut yourself, or even prick yourself with a fine needle, *blood* will flow.

In examining the flesh of an animal, after taking off the skin, we find it to be full of *blood.*

In almost every part, even in the bones, there is *blood.*

If we look very carefully at the flesh with a microscope, we find that the blood is not in it in the same way that water is in a wet sponge. It is filled with little tubes, — some of them so small that you can not see them with the naked eye, and some larger, — and the blood is contained in these tubes. They are so close together, that, if you make never so small a cut, you are sure to cut some of them, and let the blood out. These tubes are called **blood-vessels.**

2. The blood-vessels are **arteries, capillaries,** and **veins.**

3. The **arteries** are all, except one, branches of a large tube that comes out of the heart. This tube, which is called the **aorta,** runs up a little

way, and gives branches to the head and arms, and then goes down by the backbone, giving branches to the trunk of the body and the parts inside. Finally, it divides into two tubes, that run down through the legs to the feet.

4. The branches that come off from this great tube keep dividing and dividing, until, finally, the branches become so small that they are called **capillaries,** which means "*like hairs.*"

If these capillaries were laid side by side, it would take 3,000 of them to cover a space an inch wide.

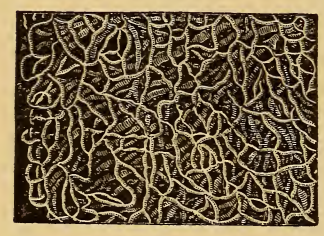

Fig. 8.
Capillary Plexus magnified.

There are a great many of them, and they make a network as close as any spider's web that you see in the grass on a summer morning. They are thick in almost every part of the body.

5. The vessels, after dividing into capillaries, soon unite to form *veins.* These veins join together, to form larger ones, just as streams join, to form larger streams and rivers. Finally, all are united in two great veins which open into the heart. The blood-vessels, which lie just beneath the skin, and which swell and look purple when you press them, are veins.

THE HEART.

6. The heart is in the breast, and lies toward the left side. If you begin at your collar-bone, on the left side, and count the ribs downward, you will find the point of the heart beating just under the fifth rib.

It is shaped like a pear. It is made of muscle.

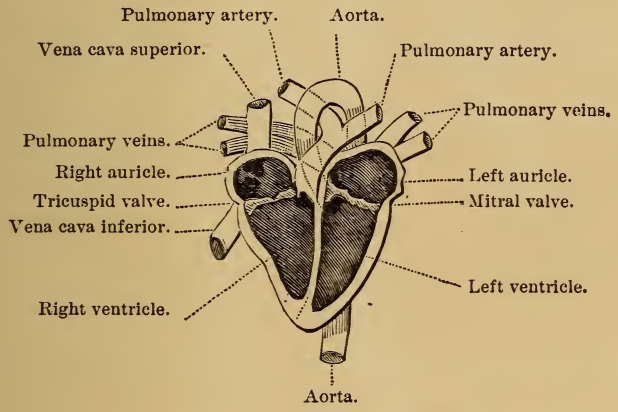

Fig. 9.

The Chambers of the Heart.

It is hollow, and is divided in the middle into two halves, which are entirely separate from each other. Each half is divided into two chambers, which are connected by an opening. The two chambers on the right side are called the **right auricle** and the **right ventricle.** The two chambers on the left side are called the **left auricle** and the **left ventricle.**

7. [1] Imagine yourself small enough to get inside the heart, and take a journey through the blood-vessels, to find out more about them. Start in the *right auricle.* If you look about you, you will find that it has thin walls, and has a lining smooth as glass. You will see three large openings in the walls. Two of them are the openings of the two great veins that empty into the heart. The third is about an inch wide, and you pass through it into the *right ventricle.* This has thicker walls than the auricle. There is only one opening to let you out of it; and you pass through this, and find yourself in a great tube with the same smooth lining that the cavities had. You are out of the heart, and are in the **pulmonary artery.**

Traveling through this artery, you soon come to a place where it divides into two, — one going to the right lung, the other to the left. You may take which you choose. As you enter the lung, you find your passage-way constantly dividing into smaller ways. You find, too, that the walls of the tubes are growing thinner, but the same glossy lining continues. Finally, you get into a passage so narrow, that, if you are more than $\frac{1}{3000}$ of an inch in size, you can not get through it without

[1] I am indebted, for the suggestion of the illustration following, to Professor Foster, Science Primer, Physiology, p. 52.

squeezing. This is a *capillary.* You are glad when the passage grows a little larger, and you find yourself in a *vein.* This leads you into a larger vein, and this into a still larger one, until you are in one of the **pulmonary veins**; and from that you plunge into another cavity. You have reached the heart again, and are in the *left auricle.* This, which is very much like the right auricle, opens into the *left ventricle.* Pausing in this cavity before you leave the heart once more, you will perceive that its walls are much thicker than those of the other cavities. Taking the only opening out of it, you enter another great tube, the **aorta**. This is of about the same size as the pulmonary artery, but its walls are thicker and stronger. As you pass on, you notice that there are many large tubes opening out of it. But you keep the main channel until at length you reach a point where it divides. Taking either of the two divisions, you move on down into the thigh, the leg, and the foot. All

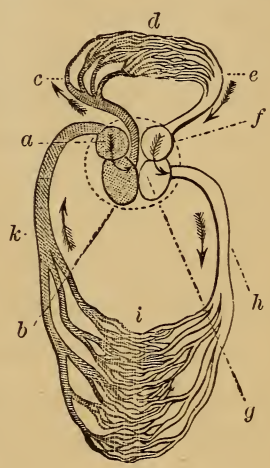

Fig. 10.

CIRCULATION IN MAN.—*a.* Right auricle. *b.* Right ventricle. *c.* Pulmonary artery. *d.* Capillaries of the lungs. *e.* Pulmonary veins. *f.* Left auricle. *g.* Left ventricle. *h.* Aorta. *i.* Capillaries. *k.* Vein.

the while your tube has been growing smaller as it gave off branches. Soon you find yourself again in a *capillary*. But it is only a fraction of an inch long, and you are quickly through it, and are in a *vein*. Passing up by the same course by which you came, the vein grows larger and larger as branches join it. You traverse the leg and thigh, and, when you reach the back again, you are in one of the two great veins which open into the *right auricle* of the heart. There you find yourself resting after your long journey.

8. As you rest, you think about two things that you have noticed.

(*1.*) You noticed that you saw no openings *out of* the blood-vessels. There were a great many different ways that you might take, but they all connected, like the paths in a park; and, though you might wander about a good while, you would always get back at last to the heart.

(*2.*) You noticed, that, at many points in your journey, you passed through *open gates*, and that they always opened in the direction in which you were going. This would not have been so, if, when you started in the right auricle, you had gone directly into a vein, and so through the veins into the capillaries, and then through the arteries back to the heart. If you had gone in that direction,

you would have found that the gates opened toward you, and that if you happened to strike against them, or if there had been a crowd trying to get through with you, you would have closed them against yourself.

This shows you that it was intended that the blood should flow in the direction in which you went, — through the arteries first, and back through the veins. It could not flow the other way, because it would close the gates against itself.

These *gates* are called **valves.** They are made of thin membrane, and are more like curtains than gates; but they are tough and strong, and fit so that they close the way perfectly.

They work like the valves in a pump, which allow the water to come up, but shut when the water settles back.

Fig. 11.
Semilunar Valves partly closed.

The valve which closes the opening between the right auricle and ventricle is called the **tricuspid** valve. The valves at the entrance of the pulmonary artery and the aorta are the **semilunar** valves. The valve between the left auricle and ventricle is the **mitral** valve. Besides these, there are valves all along the veins,

though there are none in the arteries except the semilunar valves just mentioned.

ACTION OF THE HEART.

9. If you have a pretty good idea of the heart and blood-vessels from your journey, you can now learn what they do.

We know, to begin with, that the heart and blood-vessels are full of blood. We know, also, that the blood is *always moving* through them, as rivers and streams are always flowing. We can even see it move in the blood-vessels which are in the thin web of a frog's foot, if we look at them with a microscope. We know, too, that it is always flowing in the direction which you took on your journey,— from the heart through the arteries and capillaries, and back to the heart through the veins. It is easy to find this out when an artery or vein is cut off. We can see which way the stream is running. We know, besides, that it could not flow the other way, on account of the valves.

10. The heart and blood-vessels are not like lead pipes, that simply let the water flow through them. The heart is a *live pump*. It works itself. The blood-vessels stretch and contract, and so help the heart to keep the blood moving through them.

11. If you lay your ear against any one's breast, you can hear and feel the heart *beat.* It begins to beat almost at the beginning of life, and keeps on until we die. The only rest it gets is a very short rest between the beats. But, as there are a great many beats in a day, of course there are a great many of these short rests. If they were all put together, it would make one long rest of eight hours in a day. But no other muscle does sixteen hours of constant work in twenty-four.

12. The heart beats very fast in a baby, — as many as a hundred and twenty times in a minute if he is less than a year old. In a grown man, it beats about seventy times in a minute. When we are excited, it beats faster and harder, sometimes so hard that it gives us distress. When we exercise, it beats fast.

When we are well, we do not think any thing about our hearts, or even feel that they are in our breasts.

13. What makes the heart beat, and what is it doing?

You remember that the heart is made of muscle. You remember, too, that muscle can shorten and thicken. If we could look through the breast at the heart, we would see, that, at every beat, it thickens and hardens, just as the biceps does when

you bend your elbow. At the same time, it jumps a little, and its point hits the inside of the breast. Then it softens again for an instant before the next beat.

14. Double your fist loosely, and suddenly tighten it, and you will make a motion somewhat like a heart-beat. Your fist, too, is of about the same size as your heart. Now, if you put your fist in a basin of water, and close and unclose it, the water will squirt out as you tighten your fist. That shows you what the heart does when it beats. It is full of blood; and, when it contracts, it squirts the blood out into the pulmonary artery and the aorta.

15. A common rubber syringe will show you how the heart works. The bulb of the syringe is the heart. The tube that goes into the water represents the great veins, and the other tube represents the aorta. Every squeeze you give the bulb is like a beat of the heart.

16. You know, that, in such a syringe, the water goes only one way. If you put the wrong tube in the water, it will not go. That is because there are valves in the tubes that keep the water from going backward. Just so the blood goes only one way from the heart. The valves keep it from going the other way.

17. If you should fill the bulb and the tubes with water, and then join the ends of the two tubes together so that the water could not get out, but would keep going around and around through the tubes and the bulb as you squeezed, you would have something a good deal like the circulation of the blood.

THE PULSE.

18. When you are sick, the doctor puts his finger on your wrist to feel your *pulse.* Under the end of his finger something beats, just as the heart beats against the chest, and almost at the same time.

It is a small artery that he feels. When the heart beats, it forces blood into the arteries. They were nearly full before, but they can stretch like rubber. As the blood is forced in, they stretch and swell and rise up under the finger. A pulse can be felt in several places. If you look sharply, you can see a pulse in the neck often. It is the **carotid artery** that beats there. The pulse in the wrist is generally chosen, because it is the most convenient.

19. By feeling the pulse, we may learn, among other things, —

(*1.*) How *fast* the heart beats. If we have a

fever, it beats too fast. In some sicknesses it beats too slowly.

(2.) How *strongly* it beats. If the heart is strong, the pulse will be strong. If the heart is weak, the pulse will be weak.

20. The blood flies quite swiftly through the large arteries. It moves more slowly through the capillaries. If an artery is cut, it will *spurt* out in jets. If capillaries only are cut, it will *ooze* out in drops. If a vein is cut, it will *flow* out in a steady stream.

EFFECTS OF ALCOHOL AND TOBACCO.

21. When we see a man whipping a good horse who is going fast enough, we feel angry. Now, the heart is like a willing horse. When it is making its seventy beats in a minute, it is going fast enough. It is unnecessary and foolish to use any thing that will act as a whip does on a horse, and make it beat faster. That is just what alcohol does. If it is beating seventy times in a minute, a little alcohol will often make it beat seventy-four or seventy-five times in a minute. Four or five extra beats in a minute make a great many extra beats in a day. And all these extra beats are labor lost. They are using the strength, without doing a particle of good.

22. Alcohol, when used habitually, often injures the heart and blood-vessels.

The *heart* it injures by changing its fibers partly into fat. The *blood-vessels* it injures by making them hard and brittle.

Of course, a fatty heart can not be as strong as if it were all muscle, and it can not do its work as well. It is liable to stretch and wear out before its time.

23. When the blood-vessels are brittle, a man is in danger of apoplexy.

Apoplexy is a disease caused by the breaking of a blood-vessel in the brain. The person who has it becomes paralyzed in part or all of the body. He may become insensible, and die within a few days; or he may get better, but remain paralyzed. He very seldom gets entirely well.

Young persons do not often have apoplexy, unless their blood-vessels are injured. The habit of drinking prepares the blood-vessels, and often brings on the shock.

24. The beats of a healthy heart are regular and steady, like the working of a steam-engine. When the heart is out of order, its beating is irregular and unsteady. One of the causes of such a condition is **tobacco.**

When a doctor says that Mr. A or Mr. B has a

"smoker's heart," he means that he has got his heart into this unsteady state by smoking or chewing tobacco.

QUESTIONS.

SECT. I. — **1.** How is the blood held in the tissues?

2. What are the three kinds of blood-vessels?

3. What is the aorta?

4. What are the capillaries?

5. What are the veins? Where can we see the veins?

6. Where is the heart situated? What is its shape? What is it made of? How is it divided?

7. Describe a journey through the blood-vessels, starting in the heart.

8. What two things might you notice on such a journey? What are the gates you pass? What are they like? What is the name of the gate between the right auricle and ventricle? What is the name of the gates at the beginning of the aorta and of the pulmonary artery? What is the name of the gate between the left auricle and ventricle?

9. How do we know that the blood is always moving in the blood-vessels? In which direction does it flow?

10. What machine does the heart resemble?

11. What can you hear and feel if you lay your ear against any one's breast? Does the heart get any rest? How much?

12. How fast does the heart beat? What makes it beat faster? Do we feel our hearts when we are well?

13. What makes the heart beat? Describe the process.

14. How can you illustrate a heart-beat? What is the size of the heart?

What does the heart do when it beats?

15, 16. Give another illustration of the action of the heart.

17. How can you illustrate the circulation of the blood?

18. What is the pulse? What causes the beating which you can sometimes see in the neck?

19. What can be learned by feeling the pulse?

20. How does the blood come when an artery is cut? when capillaries are cut? when a vein is cut?

21. What is the effect of alcohol on the heart? Is it wise to whip up a healthy heart?

22. What changes can alcohol make in the substance of the heart? what changes in the blood-vessels?

23. What disease threatens a man with brittle arteries? What is apoplexy? Do young persons often have it? What may cause it in a young person?

24. What is meant by the name "smoker's heart"?

CHAPTER V.

THE BLOOD. — WEAR AND REPAIR. — THE LYMPHATICS.

SECT. I. — **1.** A man has in his body about six quarts of blood, — not quite an ordinary wooden pail full. It is the most precious of all fluids. For "the blood is the life," as says Scripture. That is the reason why some people turn sick and faint when they see blood flow. It is like seeing the life go out. A man can not lose more than half of his blood, and live. The loss of much less than half might be fatal.

2. Blood is a red fluid so thick that you can not see through it.

If you put a cut finger in your mouth, you find that blood tastes salty, and has a smooth feeling to the tongue. When fresh, it is warm.

3. When any one is cut, the blood at first runs fast. In a little while, if the cut is not a very large one, it runs more slowly, and begins to grow thick; and soon it stops altogether, even if you have not done much to stop it. If any of it has dropped on the floor, it will turn in a few minutes to a jelly-like mass.

4. If you should go to the butcher's, and get a bowl full of fresh blood, and let it stand fifteen minutes, you would have a bowl full of this same jelly-like substance. This is called *clotted* blood.

5. Fresh blood always *clots* when it flows out of the blood-vessels. It is well for us that it does so. If it did not clot, it would keep on until you bled to death. It would not be safe to have a tooth pulled. As it is, the wound is soon plugged with clotted blood.

6. But why does it not clot in the blood-vessels? That we can not tell. We know that it does not, and we know that it does clot in the air. We know, too, that it clots more quickly when it is running slowly.

If you press your finger on a cut, or tie a handkerchief over it, it will check the flow of the blood, and give it a chance to clot. Then, when you take your finger or your bandage off, it will not start again.

7. Sometimes the blood flows so fast that you can not stop it by pressing on the wound, or bandaging it. This happens when a large blood-vessel is cut. If it is an artery that is bleeding, you should tie a handkerchief or a cord tight around the limb, above the wound; below the wound, if it is a vein.

8. How can you tell whether it is an artery or a vein that is bleeding?

(*1.*) Blood flows in spurts from an artery. It flows in a steady stream from a vein.

(*2.*) Blood from an artery is bright scarlet in color. Blood from a vein is darker, nearly purple.

If you can not tell by these indications, tie the handkerchief around the limb above the wound; and, if that is not sufficient, tie one below also.

These bandages can be kept on for an hour or two, if necessary, until a physician arrives.

9. If you look at a drop of blood with a microscope, you will see a watery fluid with very many little round bodies floating in it.

Fig. 12.

Red Corpuscles of Human Blood (400 diameters).

The watery fluid is called the **plasma**. The round bodies are called the **corpuscles**. Some of these corpuscles are *white*, but most of them are *red*.

The red corpuscles make rosy cheeks and cherry lips. Sometimes there are not so many of them as there should be, or they are pale in color. This makes pale faces and white lips.

10. If we lay aside our microscope, and examine blood by the aid of chemistry, we shall find that —

(*1.*) Nearly four-fifths of the blood is water.

(*2.*) The blood contains many substances, which come from the food we eat, and are for the *nourishment* of the body.

(*3.*) The blood contains waste matters, which come from the *wear* of the body.

(*4.*) The blood contains *oxygen* from the air.

The blood, then, is the carrier of *nourishment*, *waste*, *oxygen*.

WEAR AND REPAIR.

11. Now we can begin to see what the blood is for, and why the blood-vessels carry it through every nook and corner of the body, and why the heart keeps pumping day and night.

The body, like every thing else in the world, is all the time wearing out. Work and play, walking, talking, breathing, even thinking, wear it.

The little worn-out particles are of no further use. They must be cleared away. So they are drawn into the capillaries, and washed along into the veins, and, finally, they are cast out in one of three ways.

Waste matter goes out by { *the lungs.* / *the skin.* / *the kidneys.*

12. The body must be repaired as fast as it wears, or else it would soon be worn out. So

the blood must take up the nourishment that is digested, and carry it around to all the little hungry particles of flesh and bone and nerve, to make up to them for what it takes away.

13. Every little particle of the body wants *oxygen.* It can not live without it. The blood takes it in from the lungs, and carries it about for distribution. The red corpuscles are the boats in which the oxygen rides. It gets on in the lungs, and gets off in the different parts.

14. So the blood is constantly changing. It takes up something here, and gives out something there. It may be compared to a train of freight-cars, which goes through the country loading and unloading at every station. As the people at each station take out what they need, and send away what they do not want, so each particle in the body takes out from the blood what it needs, and gives up what it does not want.

15. You have learned that there are no openings out of the blood-vessels. How, then, can the nourishment from the blood get to the flesh, and how can the waste matters from the flesh get into the blood?

You remember that the arteries, as they divide and grow smaller, have thinner and thinner walls. The capillaries have the thinnest walls of all.

They are so thin and delicate, that nourishment dissolved in the blood can soak out of them, and dissolved waste matters can soak into them. Oxygen, too, can easily pass through. The capillaries are so near together, that almost every particle in the body is bathed in the fluid that soaks through them.

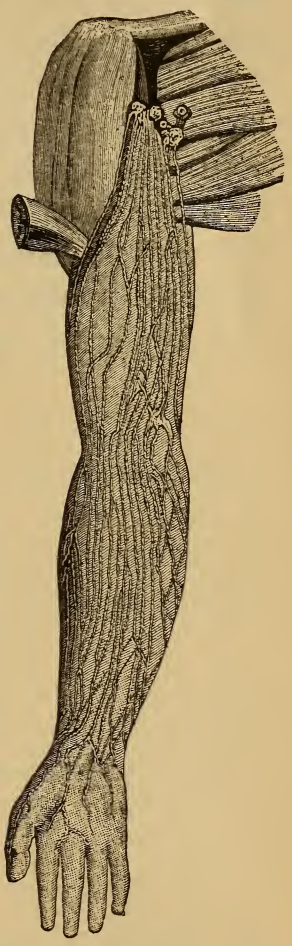

Fig. 13.
Superficial Lymphatics of the Arm.

THE LYMPHATICS.

16. A cistern or tank for water generally has an overflow pipe. There is a pipe to bring in the water, and a pump to draw it out, and, besides, a pipe near the top, through which the water can run off if it gets too full. The body has a set of *overflow pipes.* They are called **lymphatics.** These tubes do not begin at the heart, as the blood-vessels do. They begin among the capillaries all through the body. They are at first more delicate even than

the capillaries. They join together, and grow larger, just as the veins do, and run toward the heart. They do not empty into the heart, but into the great veins near the heart. So all the fluid that they take up gets finally into the blood.

17. All along the course of the lymphatics are little knots as large as a pea or a bean. These are called the **lymphatic glands.** In the neck they often swell, and are then sometimes painful.

FAINTING.

18. No part of the body can live long if its supply of blood is cut off. If a string were tied around your finger tightly enough to stop the flow of blood, and kept on, it would die. If the heart for any cause suddenly weakens, the head swims, the sense of sight and other senses fail, the consciousness is lost. This is a *fainting-fit.* It means that the brain is not getting its usual supply of blood. This weakening of the heart may be caused by fright, or bad air, or pain. Any one who is faint ought to be *laid down flat,* because in that position the blood can flow to the brain more easily; and he ought to have *fresh air,* because that makes the blood better, and stimulates the heart.

PURE BLOOD.

19. Since the blood has so much to do with the life of the body, it is very important to keep it pure.

We may keep the blood pure, —

(*1.*) *By exercise.* The blood flows faster when we exercise, and keeps purer, just as a running stream is purer than a stagnant pool.

(*2.*) *By bathing.* This keeps the skin active, and an active skin carries off impurities from the blood.

(*3.*) *By moderation in eating.* When we eat too much, the blood is loaded with more nourishment than it can dispose of.

(*4.*) *By avoiding unwholesome foods.* Some things are unwholesome, even if you take but little of them. Unripe fruit or decayed fruit is so.

Some things are wholesome if you take but little, but very unwholesome if you eat a great deal. Candy and rich cake, and sweetmeats or pickles, are of this class.

EFFECTS OF ALCOHOL AND TOBACCO.

20. Alcohol is taken into the blood, and mingles with the other substances dissolved in it. It is not just like any of them. It does not belong anywhere. It is carried swiftly around

in the current; and, wherever it goes, it stirs up commotion. It whips the heart, and excites the nerves. It goes to every station on the road; and, if there is more than a small quantity of it, they all refuse to take it in: and, finally, it is thrown out as useless by way of the lungs or skin or kidneys.

Alcohol is an impurity in the blood itself, and it causes other impurities by injuring the stomach.

A moderate use of alcohol often makes people crave too much rich and stimulating food. A great deal of alcohol takes away the appetite altogether.

21. The nicotine which is contained in tobacco is taken into the blood through the lungs, the mouth, and stomach. By the blood, it is carried to every part of the body. Its effects do not appear immediately. Often it seems as if it were having no effect. In other cases, we can clearly see that it is poisoning the whole system.

QUESTIONS.

SECT. I. — **1.** How much blood has a man in his body? How much can he lose, and yet live? Why do we feel faint at the sight of blood?

2. What is the color, taste, and feeling of blood?

3. What happens when we are wounded?

4. What is clotted blood?

5. What good purpose does clotting serve?

6. Does blood clot in the blood-vessels? How can you help it to clot in a wound?

7. What can you do when you can not stop the blood by bandaging the wound?

8. How can you tell whether blood comes from an artery or a vein?

9. How does a drop of blood look under a microscope? What is the watery part called? What are the round bodies called? What is the color of the round bodies? What makes rosy cheeks?

10. What is the chief part of the blood?

What three things does the blood contain? Where does each one of these things come from?

11. Does the body wear? What becomes of the worn-out particles?

By what three ways does waste matter go out of the body?

12. How is the body repaired?

13. How is the oxygen carried in the blood?

14. Is the blood always the same?

How is it like a freight-train?

15. How does nourishment get out of the blood, and waste matter get in?

16. What are the lymphatics? What do they do?

17. What are the lymphatic glands?

18. What is constantly needful for the life of the body? What is a fainting-fit? What should be done with a person who has fainted? Why?

19. Why is it important to keep the blood pure? How may we keep it pure?

Is unripe fruit ever wholesome?

Are candy and cake ever wholesome?

20. What does alcohol do in the blood? What becomes of it at last?

How does alcohol affect the appetite?

21. How does nicotine enter the blood? What is its effect?

CHAPTER VI.

FOOD AND WATER. — STIMULANTS AND NARCOTICS.

SECT. I. — **1.** The blood carries *nourishment* to every particle of the body. Let us inquire now what this nourishment is, and where it comes from. It is contained in *food* and *water*. And all our food and water come from the earth and the air. Think of this, and see if you can remember any kind of food that does not come from the earth or air.

2. Perhaps you will say, beef does not. But it does. For the ox lives on grass and grain, and grass and grain come from the earth and air. So with all kinds of meat. The food of all animals comes at last from plants.

3. The food of plants is the air and the minerals which are dissolved in the earth.

Animals can not live on air and minerals. Plants can. That is one great difference between animals and plants. And one great business of the plants is to take air and minerals into themselves, and make them into food for animals.

Probably every plant is food for some kind of animal, big or little.

4. If you were lost in a forest, you would very likely starve to death. All around you the birds would be full of life, and the rabbits and squirrels and foxes would be growing fat. But, unless you could manage to catch some of these animals, you would have nothing to eat. What is food for a bird or a squirrel or a horse, is not food for you.

But there are some plants that you can eat. It is the business of farmers to raise these plants. Farmers also take care of the animals that are food for men.

ANIMAL FOOD.

5. The most nourishing animal food is *beef*. *Lamb* and *mutton* and *fowls* come next. Many people eat *pork* more than any other meat. It is not so digestible or healthful as beef and mutton. It ought always to be well cooked.

Raw ham and raw sausages are dangerous. They often contain a little worm, called the *trichina*, which causes a severe disease in those who eat them. The trichina is killed by thorough cooking.

6. *Fish* is a light and digestible food. But it is much better on the seacoast, or near the places where it is caught, than elsewhere. It spoils by

being kept, sooner than beef or mutton, and is likely to lose its fine flavor when it is carried far.

7. *Oysters* are a favorite food with very many. They are easily digested and nutritious. It is a good rule to eat them only in the months that have an *r* in them.

8. *Eggs* contain a great deal of nourishment, and are easily eaten.

9. There is no one food as valuable as *milk*. Infants live on it for the first year or two, and sick people can live a long time on it when they can not take any thing else.

VEGETABLE FOOD.

10. The principal grains used as food are *wheat*, *rice*, *corn*, *oats*, *rye*, and *barley*.

Many millions of the human family live on *rice*. It is the chief food in China, India, and some other countries.

In Europe and America, *wheat* is the most valued grain. *Corn* contains the most oil, and is a richer food than the others. *Oatmeal* contains much bran, and is a coarse article of diet; but it is wholesome for most people.

11. No vegetable is used more generally in civilized countries than the *potato*. It is a native of North America, and was introduced into Europe

three hundred years ago. Since that time it has become the chief food of great numbers of people. No other vegetable is so light and delicate.

12. Dried *pease* and *beans* are hard to digest, because they contain so much solid matter. But, for this very reason, they are good for armies, or for men who are exploring or hunting, who have to carry a good deal of nourishment in small bulk.

13. Green *garden vegetables* are healthful, on account of the juices which they contain.

COOKING.

14. Animals eat their food raw. Men cook most of theirs. Cooking makes food more digestible, and it gives good flavors. It makes a great difference with our appetites whether our food is well cooked, or not. There is no art which has more to do with health and comfort than cookery. It is therefore worth learning.

15. *Bread* is so large a part of our diet, that it is worthy of more attention than any other article. Good bread is *light* and *sweet*. In order to have it light and sweet, you must have, —

(*1.*) Good *flour*.

(*2.*) Good *yeast*.

(*3.*) Good *mixing*.

(*4.*) Good *judgment*.

The good judgment must be gained by experience, and is used in deciding when the mass is warm enough, when it has risen long enough, when the oven is hot enough, and when the bread should be taken out.

Sour bread makes sour tempers.

Hot bread is not so light and digestible generally as cold bread.

16. Besides bread, *pastry* and *cake* are made of grain. These contain lard or butter, and sugar. This makes them rich, and pleasant to the taste. A moderate quantity of them does no harm; but, if we eat heartily of such food, we are giving the stomach too much work to do.

MINERAL FOOD.

17. The only mineral that we eat by itself is *salt*. It is a great hardship to be deprived of it. It helps digestion, and is very necessary in the body. Some animals need it as much as men. The cattle on the Western plains will go a long distance to find a salt-spring.

But it is poison to fowls.

Other mineral substances are contained in many articles of food.

WATER.

18. When we remember that about *eight-tenths*

of the blood is water, and that about *seven-tenths* of the whole body is water, and that we are losing water constantly through the lungs and the skin and the kidneys, we can see why it is so necessary to us. We can bear to go without food better than to be deprived of water.

19. Good drinking-water is clear and transparent, and it has no taste or odor. But even water with no taste or odor is sometimes bad. There are many poisonous substances which may be dissolved in water, which will not give it any smell or taste or color. People often drink bad water without knowing that it is bad.

It is important to be careful of the drinking-water, to see to it that nothing harmful gets into it.

20. Water that runs through lead pipes may have a little *lead* dissolved in it. You can not taste it or smell it or see it. It does not make you sick at once. But by and by you find that a disease is upon you. Even if you stop drinking the water, it may be a long time before you are well.

Intoxicating drinks sometimes act just like water with lead in it. They do not seem to do any harm at first. The drinker is well, and they make him feel better. But by and by he knows that they are injuring him. Then, when he tries

to stop, he finds that he has got a habit of taking them which he can not easily break.

It is not safe to use lead pipes unless we know that the water we use does not act on them. It may be necessary to ask the opinion of a chemist.

21. Water may have foul matters in it from sewers and drains. This sometimes happens to the drinking-water of cities. You would suppose, that, in the country, the water would always be pure. But, in many a farmhouse, they are drinking water that has in it slops from the sink, or drainings from the barnyard. So they get typhoid fevers, and other diseases.

22. The well should never be within thirty feet of a pigpen or barnyard, or other foul spot. It should never be where the ground slopes down to it from any such place.

When it is necessary to use water that is not pure, it should be boiled and filtered. This makes it safer.

HABITS.

23. People of different countries prefer different foods. In Ireland, the potato holds the first place; in Scotland, oatmeal; in India and China, rice. In hot climates, a very little food is sufficient. An Arab can travel all day with no other food than a handful of grain; but an Esquimau, after fasting,

will eat several pounds of clear fat at a meal. In some countries, almost nothing is eaten before noon. In cold northern latitudes, people want a hearty breakfast.

24. So people in the same country differ in their habits. One prefers one kind of food, and another another kind. One dines at noon, another at night. It is not necessary that all should have the same habits, but there are some rules which all should observe.

We should remember that we *eat to live*, and do not *live to eat.*

We should *eat nothing that we know to be harmful to us*, even if it be very pleasant to the taste.

We should *not eat too much.*

STIMULANTS AND NARCOTICS.

SECT. II.—**1.** Did you ever get too much pepper in your mouth? Did it make your tongue smart, and set you to coughing, and make your eyes water? If so, you know what a **stimulant** is. To stimulate means to excite, to stir up, to irritate. A *stimulant* is any thing that excites and stirs up and irritates. The pepper irritated your tongue and throat, and stirred you up.

2. Mustard is another stimulant. Horse-radish, spices of all kinds, and many herbs, are stimulants.

We want only a little of them with our food, — so little, that they are not worth any thing for the nourishment they contain. But they give food a flavor, and arouse the appetite.

In this way pepper and mustard may not be harmful if used moderately.

3. But, after all, "Hunger is the best sauce." What we really want, when we sit down to eat, is the *nourishment* that is in the plain food, and not the *pleasure* that the taste of spices gives us. One whose health is good does not often need to have his appetite stimulated. By spiced and highly seasoned food, we are easily tempted to eat too much.

4. Such food is not as well digested. The good stomach, which is faithfully doing its work, does not like to be stirred up by too much spice, any more than your tongue likes too much pepper; so it feels badly, and can not act as well.

5. By indulgence in any kind of stimulants, the *desire for them is likely to increase.* We may learn to bear larger and larger quantities, until all food that is not very highly flavored seems flat to us.

TEA AND COFFEE.

6. *Tea* and *coffee* are stimulating drinks. Tea is made from the leaf of a plant which is cultivated

in China and Japan, and coffee from a berry which is brought from Arabia, and other warm countries. Like the food-stimulants just spoken of, they do not afford much nourishment. They are used for the warmth and comfort which they give.

7. Probably you are not allowed to have any. This is right. Grown persons are not injured by them so much as children, whose bodies are more delicate, would be. But grown people are sometimes injured very much by them. They hurt their stomachs, and give them headaches, and make them nervous and fretful and unhappy. Some people ought never to use tea and coffee. Every one ought to be careful, and not take too much.

OPIUM.

8. When a person is sick and in pain, the doctor sometimes gives him a dose of *opium*. In a little while, the pain grows less and less, and then goes away entirely. Instead of groaning and crying, he can smile. Then he finds that he is drowsy. His eyelids droop. He forgets his trouble, and soon he is quietly sleeping. It is the opium that has done this.

9. There are many other drugs, which, like opium, can make a person quiet or drowsy or unconscious. We call them **narcotics**. Some things

are both stimulants and narcotics. If a man takes a single glass of wine, it is a stimulant. It excites him. If he takes a great many, and becomes drunk and stupid, it is a narcotic.

10. *Opium* is a blessing when properly used by the physician. But, when improperly used, it is a terrible evil. Those who take it a good while come to depend on it. It is even harder to give it up than to give up drinking. People use it, not to relieve pain only, but because it gives pleasure. They may not know, when they begin, that it can harm them. At first they only feel the pleasant effects. But by and by they find that it is making them sick and weak in body and mind. They become good for nothing. Since there is this danger in it, it ought never to be taken except when the doctor orders it.

11. *Opium* is the juice of the poppy. This plant grows in our gardens, and has a beautiful flower; but most of the opium is brought from the East, where fields of poppies are cultivated. *Laudanum* is opium in a liquid form. *Morphine* is a white powder which is made from opium. It has the same effects, but it does not take so much of it to produce them.

TOBACCO.

12. *Tobacco* is the leaf of a plant which was found in this country when it was discovered by Europeans. The Indians taught the new-comers the use of it. After being thoroughly dried, it is smoked and chewed and snuffed. A great many men use it, and some boys. They do it because they like its effects. They say it makes them feel better, and helps them to do their work.

13. Some men who use tobacco do not seem to be injured by it. They are healthy and strong, and live to be old. Others are injured very much. Sometimes they do not know that it is hurting them. Sometimes they know it, but can not give it up.

The first time it is used, it makes the user deathly sick. Nature rebels against it. After a time, it does not cause sickness, but gives pleasure.

14. But, while it is giving pleasure, it may be doing harm in several ways, —

(*1.*) By weakening the stomach.

(*2.*) By making the throat sore. Smokers often have sore throat. Cancer in the throat or mouth is at times occasioned by smoking.

(*3.*) By disturbing the heart. It makes it irregular and weak.

(*4.*) By making the nerves unsteady.

15. Tobacco is especially bad for *boys.* It may stop the body and mind from growing, and make them feeble and unhealthy in every part.

ALCOHOLIC DRINKS.

16. *Wines* are made of the juice of grapes or berries. *Beer, ale, porter,* and *whisky* are made from grain. *Brandy* is made from wine and cider and some other liquors. *Rum* is made from sugar-cane or molasses. All these drinks contain alcohol, and it is for the alcohol in them that they are used.

17. *Alcohol* looks like water. It burns the mouth like fire if it is taken clear. Brandy is about half alcohol. Wine is from one-tenth to one-fifth alcohol.

18. Many men spend more money to get alcoholic drinks than they spend for food or clothes or any thing else. Why do they want them so much?

You have already learned, that, when you take any stimulant for a while, you are likely to get fond of it, and to want more and more of it. This is especially so with alcoholic drinks. The appetite for them often keeps growing, until it is stronger than any other desire. A moderate

drinker is always in some danger of becoming a drunkard, and a drunkard will give up every thing for liquor.

19. All stimulants are sometimes an injury to those who use them. But no other one has such power as alcohol. It can change a man into something worse than a beast. It can take away his property and his home. It can destroy his character.

It makes more people poor and unhappy and wicked than any other cause.

QUESTIONS.

SECT. I. — **1.** What is our nourishment contained in? Where does it all come from?

2. From what does the food of all animals come?

3. What is the food of plants? What great difference is there between plants and animals? What service do plants render to animals?

4. Can all animals live on the same food? From whom do we get our food?

5. What is the most nourishing animal food? What comes next? What caution should be observed in eating pork?

6. What caution should be observed in buying fish?

7. In what months are oysters best?

9. Which is the most valuable food?

10. Name the principal grains used as food.

What is the chief food in China and India?

What grain is most valued in Europe and America?

11. What vegetable stands first, in usefulness?

12. For what purpose are dried pease and beans very valuable?

14. Is good cooking important?

15. What is necessary for making good bread?

16. What is the difference between bread and cake and pastry? Are cake and pastry wholesome?

17. What mineral do we eat with our food? Do we eat any other minerals in our food?

18. How much of the blood is water? How much of the body is water? Why must we keep drinking it?

19. Describe good drinking-water. Is all water good that looks and seems good?

20. What mineral sometimes gets into water? How are intoxicating drinks like poisoned water?

What should we be sure of if we drink water that comes through lead pipes? How can we be sure of it?

21. What injurious substances that are not minerals get into water? What is a result of drinking such water?

22. What is the rule about the position of the well? How can we make bad water safer?

23. Do all countries have the same habits of eating?

24. Do people in the same country have the same habits of eating? Is it important that they should?

What rules ought all to remember?

SECT. II. — **1.** What is a stimulant?

2. What is the use of stimulants?

3. What is the chief object of eating? Do stimulants contain much nourishment?

4. What is the harm of food stimulants?

5. What is the danger of indulgence in them?

6. What is tea? What is coffee? What are they used for?

7. Are tea and coffee good for children? Are they always good for grown people?

8. What is the effect of opium?

9. What is a narcotic?

10. How does opium do harm? Is it safe to use it?

11. What is opium? laudanum? morphine?

12. What is tobacco? Why do men use it?

13. What are its effects?

14. How may it do harm?

15. Who are most injured by tobacco?

16. Name some alcoholic drinks, and state what they are made of.

17. What does alcohol look like? How much alcohol is there in brandy? How much in wine?

18. Why do men spend so much money for alcoholic drinks?

19. What does alcohol do?

CHAPTER VII.

DIGESTION. — ABSORPTION.

SECT. I. — **1.** Let us suppose ourselves to be examining the body of a dead animal. We have studied the skin, and have removed it. We have studied the muscles (or flesh) which lie beneath. With the aid of a microscope we have studied the blood which flows as we cut the flesh. We will next cut through into the inside, and see what we find there.

2. We find, first, that the inside of the trunk is divided into two parts by a thin partition, that extends across from the breast-bone to the back-bone. This partition is called the **diaphragm**. It is made of muscle, and can move up and down. The part above the diaphragm is called the **thorax**, or *chest*. The part below is called the **abdomen**, or *belly*.

3. The things that we notice in the chest are, *two lungs*, a *heart*, and a soft fleshy tube which runs through it from top to bottom. This tube is the **œsophagus**, or *gullet*.

4. In the *abdomen* we see the **liver**, the **pan-**

creas, the **spleen,** the **kidneys,** the **stomach,** and the **intestines,** or *bowels.*

5. If we follow the soft tube — the *gullet* — that we noticed in the chest, upwards, we find that it opens into the *throat*, and the throat opens into the *mouth.* If we follow it downwards, we find that it goes through a hole in the diaphragm, and then it opens into one end of the *stomach.* If we follow on to the other end of the stomach, we find that the stomach opens into the *bowels.* The *bowels* are coiled up in the abdomen, and end at the lower end of the trunk.

6. This long tube, which begins at the lips, and extends through the trunk, is called the **alimentary canal.** *Aliment* is *nourishment.* The *alimentary canal* is the canal in which nourishment is made fit to be taken into the blood.

7. The *alimentary canal* is to the body what the kitchen is to the house. Food, as it comes from the butcher and the grocer, is first carried to the kitchen. There it is cut up and ground and cooked; and finally it comes to us in nice, tempting dishes, to satisfy the hunger of the family.

So, in the alimentary canal, the food we eat is cut up, and the nourishing part is separated from that which is not nourishing, and is softened to a

liquid, and changed so that it can be taken into the blood, and carried to all parts of the body. We call this **digestion.**

8. This canal is very important, and we must study it further.

The alimentary canal is from twenty-five to

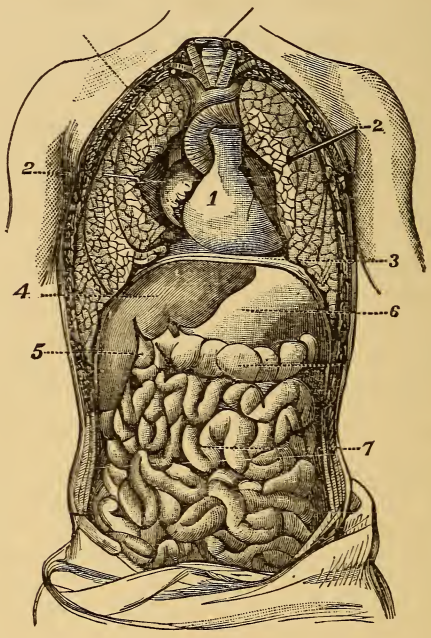

Fig. 14.

1. The Heart. 2. The Lungs. 3. The Diaphragm. 4. The Liver. 5. The Gall-Bladder. 6. The Stomach. 7. The Bowels.

thirty feet long in a man. Of course, in order to get such a long tube into the trunk, which is only about two feet long, part of it must be rolled

up in a coil. The coil is the part of the tube that we call the *bowels.*

9. The *lips* are the gates which close the entrance to the canal. Behind these gates is the first cavity, the *mouth.* Liquid food does not stay in the mouth, but passes directly through it. Solid food must be chewed before it can go on.

10. A baby when he is born has no *teeth.* But by the time he is six or seven months old they begin to come. The lower front teeth are the first to peep out. At two years of age he will have twenty teeth. This is his first set, called *milk teeth* or *baby teeth.* At about five years of age he begins to lose these, and new ones take their places. The new ones keep coming; and the last, which are called *wisdom teeth,* may not appear before twenty-five or thirty years of age. A grown person has thirty-two teeth, — twelve more than a child.

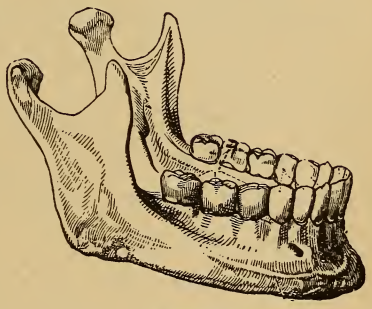

Fig. 15.
The Lower Teeth.

11. The front teeth are flat and sharp, like chisels. They are for cutting. Two on each side — the eye-tooth and the stomach-tooth — are

pointed for holding on to things. The back teeth have broad ends for grinding.

12. Each tooth has one or more *roots*, which fit in a socket in the jaw-bone. The surface of the tooth is *enamel*, which is the hardest substance in the body. In the center of the tooth is a canal which contains little blood-vessels and nerves.

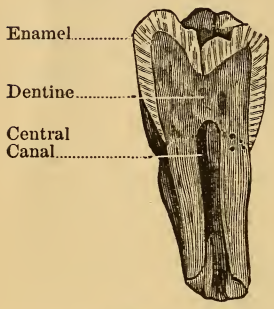

Fig. 16.
Back Tooth sawed in two.

13. Teeth are liable to decay. When they do so, they are sensitive and painful; and finally they crumble away entirely. If we lose one of our first teeth, it is not much of a loss; for a new one will soon grow. If we lose a second tooth, the dentist must make us another, or we must go without.

14. People do not look as well when their teeth are gone; and, besides, they can not chew their food as well.

It is important, therefore, to take good care of the teeth.

We must not bite nuts or other hard things with them. If they are broken or chipped, they can not be restored.

We must keep them clean. They should be

well brushed every day. Food left between the teeth injures them.

If they begin to decay, they should be taken care of immediately by a dentist. He can often save them.

15. When you bite any thing, your lower jaw moves down and up. When you chew any thing, it moves from side to side, as well as down and up, so that the food is ground between your back teeth.

16. The *tongue* is made of muscle. Some of the fibers run lengthwise, some crosswise, some up and down. It can lengthen and thicken, and move in every possible direction.

17. Now, suppose you have bitten off a piece of bread. Immediately your jaw moves down and up and sidewise. Your tongue and cheeks keep the morsel all the time between your teeth, sometimes shifting it from one side of the mouth to the other; and so it is cut and ground into fine bits.

18. While you are chewing, your mouth is moist. As soon as you begin, — sometimes before you begin, when you are thinking of nice food, — your mouth waters. This water is the **saliva.** It comes from six lumps, which are called the **salivary glands.** Two of them are just under

the ears. When we have *mumps*, these swell up, and are sore. Four of them are under the floor of the mouth. These glands make the saliva

Fig. 17.
Salivary Glands.

out of the blood, in the same way that the sweat-glands make sweat from the blood. A little tube runs from each of them, which opens into the mouth. The saliva pours through these tubes.

19. Your mouthful of bread, while it is being cut up and ground, is being moistened with saliva. When you are ready to swallow it, it is a soft pulp.

If you are in a hurry, you may manage to swallow food that is not thoroughly chewed, and mixed with saliva. This gives the stomach more

work to do. Sometimes it makes it ache. So we should be sure and take time enough.

20. When we *swallow*, the tongue forces the morsel of food into the throat, and the muscles of the throat close around it, and squeeze it down into the gullet. Then the walls of the gullet, which are muscle, contract behind it, and squeeze it down into the stomach. If you look at a horse when he is drinking, you can see the swallows of water passing one after another along his neck.

21. The **stomach** is a part of the alimentary canal which is larger than the rest. It is a pouch in which the food stays some time, and is changed a good deal. In a man it is about twelve inches long, and three or four inches wide. It lies just under the heart. When it is full, it presses up against the heart and lungs; and that is the reason why we are short of breath if we run just after dinner.

22. The wall of the stomach is partly muscle. It has a pink lining, like the lining of the mouth. This lining is full of little pits shaped like the finger of a glove. They are the **stomach-glands.** They make the **gastric juice** from the blood, and the gastric juice digests a part of the food.

23. As soon as the morsel which is swallowed

drops into the stomach, the blood comes to its lining, and makes it redden, just as your face reddens when you blush. Then the stomach-glands make gastric juice quickly. At the same

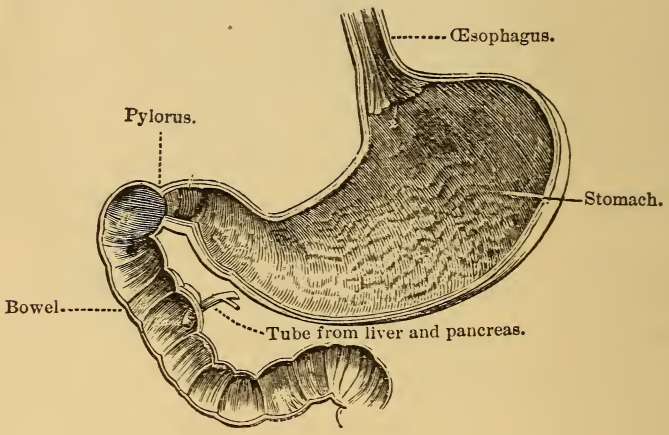

Fig. 18.

Section of the Stomach.

time, the walls of the stomach contract, and squeeze the food, as if you should put some pudding in a bag, and squeeze it with your hands. In this way, the gastric juice is well mixed with it. You do not know by your feelings that your stomach is contracting in this way. The muscle in it is involuntary muscle, and it contracts of itself.

When the food has been kneaded in this way long enough, it slips out of the stomach into the bowels.

24. At the beginning of the bowels, at the right end of the stomach, there is a ring of muscle around the tube, which is called the **pylorus.** Pylorus means "keeper of the gate." Until the food has been thoroughly acted on by the stomach, this keeper shuts the gate, and will not let it out.

25. When you eat too much, or take unwholesome food, such as unripe fruit, the stomach tries to digest it, and finds it can not. Then it wants to get rid of it. The *pylorus* will not let the food out in that way; so the stomach makes a great effort, with the help of some other muscles, and throws it out by the same way through which it came in. Then the stomach feels better.

26. In 1822 a Canadian, named St. Martin, was shot in the left side in such a way, that, when he got well, there was a hole into his stomach. Through this hole, the inside of the stomach could be seen, and things could be put in, and taken out. In this way, much of what we know about the action of the stomach was learned.

27. When the stomach is through with the food, the *pylorus* opens the gateway, and lets it into the *bowels.* Near the beginning of the bowels, a small opening can be found. Two tubes are connected with this opening. One comes from the **liver,** the other from the **pancreas.**

28. The *liver* is a solid mass weighing four pounds. It is under the edge of the ribs, most of it on the right side. It makes yellow *bile* from the blood which runs through it. This bile is poured

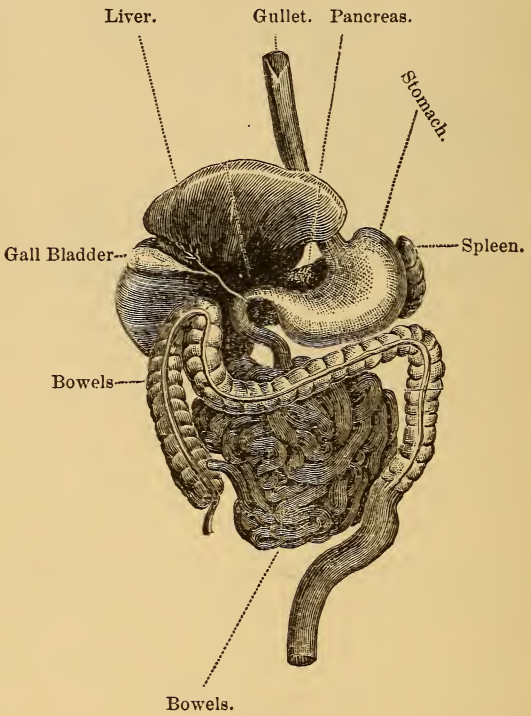

Fig. 19.

The Liver and other Organs of Digestion.

out, through the tube just spoken of, into the upper end of the bowels. There it mixes with the food, and helps digestion. The liver also makes, and stores up in itself, a substance called

glycogen. Glycogen is changed into sugar for the use of the body as it is wanted.

29. The **gall-bladder** is a little sac shaped like a pear, which is attached to the under side of the liver. Some of the bile made by the liver is stored up in the gall-bladder when it is not needed in the bowels.

30. The tube from the liver sometimes gets clogged. That dams up the bile; and the bile gets into the blood, and is carried all through the body. It gives a yellow color to the skin and the eyes. This disease is called *jaundice.*

31. The tube from the *pancreas* ends at the same opening with the tube from the liver. The pancreas is the *sweetbread* in calves. It is six or seven inches long, and lies across the backbone behind the stomach. The fluid that it makes is called the *pancreatic juice.* This mixes with the food in the bowels, and helps to digest it.

32. The lining of the bowels is filled with little pits similar to those in the stomach. They make the *intestinal juice.*

Divisions of the Alimentary Canal.

The mouth. The œsophagus.
The throat. The stomach.
The bowels.

Fluids of the Alimentary Canal.

The saliva. The bile.
The gastric juice. The pancreatic juice.
The intestinal juice.

ABSORPTION.

SECT. II. — **1.** Perhaps you are ready to ask how the nutriment gets into the blood after it is prepared by digestion, since there is no opening out of the alimentary canal.

If you should examine the lining of the alimentary canal very carefully, you would see that it is full of the little blood-vessels called capillaries. The walls of these vessels are thinner than the thinnest paper. The nutriment which has been dissolved by the juices in the alimentary canal soaks through into these vessels, and is carried by the current of the blood to all parts of the body. The soaking process is called *absorption.*

2. Absorption goes on in all parts of the alimentary canal. As the nutriment is digested, it is absorbed. A good deal is taken out of the stomach. While the food moves down through the bowels, more and more of it is absorbed, until at last there is no nutriment left. Only those parts of the food remain which can not be digested.

3. If we are well, and eat only wholesome food, we shall not have to think any thing about our digestion. It takes care of itself. But, if we are not reasonable about our eating, we may have a great deal of trouble. **Dyspepsia** means bad digestion. Since it is our food that gives us strength and comfort, we shall not be strong or happy if we can not digest well. *Dyspeptics* suffer a great deal, and we should take good care not to get dyspepsia.

RULES FOR THE CARE OF THE STOMACH.

SECT. III. — **1.** We should not eat *too fast.* It takes time to chew our food properly. If we swallow it down in lumps, the stomach will have hard labor to take care of it.

2. We should not eat *too much.* If we feel heavy and full after a meal, it is a sign that we are not well, or that we have overloaded our stomachs. It is foolish to stuff down food which we do not need because it tastes well.

3. We should not eat *too often.* The stomach needs rest as well as the other parts of the body. If we keep it at work continually, it will wear out.

4. *Pie* and *cake* and *candy* should not be eaten freely, like bread or fruit. A little of such food is sufficient.

5. When you find that any thing you eat *hurts you*, do not eat of it again. If you have eaten green apples or cucumbers, and have had a stomach-ache after it, let them alone in future. If you have eaten two pieces of pie, and feel sick, eat only one piece next time. If you feel badly after eating any thing, it is a sign that it is not good for you. That is the way Mother Nature teaches us.

EFFECTS OF ALCOHOL AND TOBACCO.

SECT. IV. — **1.** Alcohol is a fiery *stimulant*. You remember what a stimulant does in your mouth, —such an one as pepper, for instance. Alcohol you could not keep in your mouth a moment.

2. The mouth and stomach are made for simple food. If we are well, they do not need any strong stimulants. Too much mustard or tea is bad for them.

3. Alcohol is a much more dangerous stimulant than these. Nobody drinks clear alcohol. The strongest drinks are about one-half alcohol, and the weakest have only three or four spoonfuls to a tumblerful.

4. But you have learned, that, when we like any stimulant, we are apt to want more and more of it, until we get so that we need a great deal to satisfy us.

No stimulant is so *enticing* as alcohol. It is very easy to get into the habit of using a great deal of it.

5. Since the stomach was not made to need strong stimulants, it *hurts it* to use them.

Dr. Beaumont found, that when St. Martin took wine, beer, or any of the intoxicating liquors freely for some days, the lining of his stomach looked red and inflamed and sore, and the gastric juice became thick and ropy.

6. If a boy handles a bat a good deal, he may get his hands blistered at first. By and by the skin will grow thick and hard. In the same way, the ends of a girl's fingers may get hardened by sewing. So, if the stomach is irritated constantly by alcohol, it will grow thick and tough.

7. An old toper can drink a great deal of strong liquor without feeling it. That is because his stomach has changed. It is a better stomach to hold alcohol, but not so good a stomach to digest food.

8. Drinking often causes *dyspepsia.* It takes away the appetite, and spoils the gastric juice.

After long use of alcohol, the stomach sometimes gets into such a condition that it will not bear food at all, without being first roused by drink.

9. Drinking often causes *diseases of the liver.*

10. He who uses *tobacco* for the first time finds to his cost that it also has a powerful effect on the stomach. It has a tendency to take away the appetite for food, and, in many cases, is one of the causes of dyspepsia.

QUESTIONS.

SECT. I.—**1, 2.** What is the name of the partition which divides the inside of the trunk? What is the name of the part above the partition? of the part below the partition?

3. What do we notice in the chest?

4. What do we notice in the abdomen?

5. If we follow the gullet up, what do we find? If we follow it down, where does it lead us? Where are the bowels situated?

6. What is the name of the long tube we have just been tracing? What is aliment?

7. What may the alimentary canal be compared to? What is digestion?

8. How long is the alimentary canal? How can so long a tube be contained in the trunk?

9. Where does the alimentary canal begin? What is the first cavity in it?

10. When do a baby's teeth begin to come? When does he have them all? How many has he? When does he begin to lose his first teeth? When does a grown person have all his teeth? How many has he?

11. Are the teeth all alike?

12. Describe a tooth.

13. Do teeth decay?

14. Why is it important to take care of the teeth? Mention three rules for taking care of the teeth.

15. What are the motions of the lower jaw?

16. Describe the tongue.

17, 18. What is done with food in the mouth? What is saliva? Where does it come from? What is swollen when you have mumps? How is saliva carried into the mouth? What do you mean when you say your mouth waters?

19. What is the harm of eating too fast?

20. Describe the process of swallowing.

21. What is the stomach? its size? its position? Why are we short-breathed when we run after dinner?

22. What is the wall of the stomach partly made of? What are the stomach-glands? What do they make?

23. Describe what takes place in the stomach when food enters it.

24. What is the pylorus? What does it do?

25. How does the stomach sometimes relieve itself of indigestible food?

26. How do we know what goes on in the stomach?

27. Where does the food go when it leaves the stomach?

28. What is the liver? What two things does it do?

29. What is the gall-bladder?

30. What is jaundice?

31. What is the pancreas? What is it for?

32. What is the intestinal juice?

Name the divisions of the alimentary canal.

Name the fluids of the alimentary canal.

SECT. II. — **1.** How does nutriment get into the blood?

2. Where does absorption go on?

3. What is dyspepsia?

SECT. III. — **1-5.** Give five rules for the care of the stomach, with the reason for each.

SECT. IV. — **1.** What effect has alcohol in the mouth?

2. Does the healthy mouth and stomach need strong stimulants?

3. Is clear alcohol used as a drink?

4. What is one of the chief dangers of alcohol?

5. What can alcohol do to the stomach?

6, 7. How may alcohol change the stomach?

8. What disease of the stomach does drinking often cause?

9. How does drinking affect the liver?

10. What effect may tobacco have on the stomach?

CHAPTER VIII.

RESPIRATION.—THE VOICE.

SECT. I.—**1.** You might live several days without food and water, but you could not live five minutes without *air*. If any thing covers your mouth or nose, so as to prevent your breathing, you are in distress until you get it away. If you should sink under water, you would die, because the water would shut out the air.

2. All animals need air. Even fishes must have it. There is some air dissolved in water. If you put a fish in a glass jar full of water, and then, with an air-pump, draw the air out of the water, in a little while the fish will die. A fish breathes with his gills, and they are made to use the air which is in the water. When you take him out of the water, his gills get dry, and do not work well. He dies for want of air, as we should in the water.

Fig. 20.
The Gills of an Eel.

Plants, too, would soon perish, if you could take the air entirely from them.

Because air is necessary for us all the time, the Creator has given it to us freely. We have to work for our food. Even water may be scarce. But every one can have as much air as he needs, without price. We have only to *breathe* it.

3. What is *breathing?* Drawing the air in, and letting it go out, you say. But, if I ask you how you draw it in, you might not be able to tell me, though it is perfectly easy for you to do it.

4. When we looked into the chest, we found there, besides the heart and the gullet, two **lungs,** one on each side. They are smooth, pinkish masses, and not so hard but that you can poke your finger through one. You can easily get some to examine at the butcher's. He calls them the "lights."

5. The root of each lung is a bundle of tubes, which lie close together. These tubes are the blood-vessels which go to and from the heart, and the air-tube. The air-tubes of the two lungs join, in front of the backbone, to form the **trachea,** or *windpipe.* The windpipe is four or five inches long, and from half an inch to an inch across. If you follow it up through the neck, you find that it opens into the throat, and so connects with the mouth and nose.

It is through the mouth and nose that the air is drawn in.

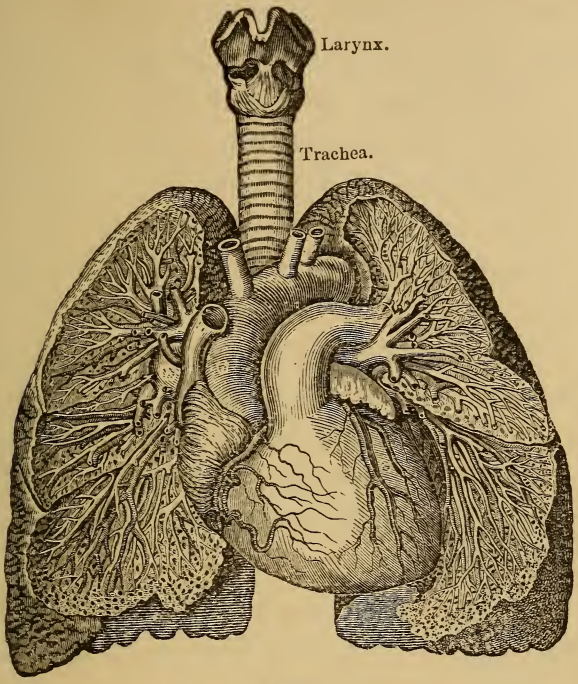

Fig. 21.

Heart and Lungs.

6. The **nose** is the true breathing-passage. The two openings of the nose we call the *nostrils.* Beyond these openings are two high and narrow passage-ways, which go straight back, and open into the throat just above the palate.

7. There are two reasons why it is better to breathe through the nose than through the mouth.

The first reason is, that the air gets *warmed* in passing through the nose. The passages are nar-

row; and the stream of air is therefore thinner, and more easily warmed by the warm walls.

The second reason is, that the air gets *moistened* in passing through the nose. The walls of these narrow passages are lined with a reddish membrane, like the lining of the mouth. It is both warm and moist, and gives its moisture to the thin stream of air.

8. When we breathe through the mouth, the air is colder and drier when it reaches the throat. We all know how dry the mouth will get when we run, and breathe fast through it. People who breathe through the mouth all the time are more liable to have sore throats.

9. Whoever has a disease which stops up the nose, and prevents his breathing through it, ought to have it cured if possible.

Snoring is caused by breathing through the mouth. People who sleep with their mouths closed do not snore.

10. Besides serving us for breathing, the nose is the organ of *smell.* The nerves of smell are in the upper part of the nose. Therefore, if we wish to smell any thing distinctly, instead of drawing the air quietly through in the usual way, we sniff, and draw it up.

11. The food and the air both go into the throat.

There they part company. The food goes down the gullet, and the air goes down the windpipe. Sometimes we swallow a little air. Sometimes a drop of water, or a particle of food, is "swallowed the wrong way," and gets into the windpipe. This makes us cough furiously until we get it out. But generally food and air each takes its own course. It is wonderful that they do so. There are nerves that keep guard over the entrance to the windpipe, and make it open and close at the right time, as the switch-tender at the depot opens and closes the switches, and sends each train on its own track.

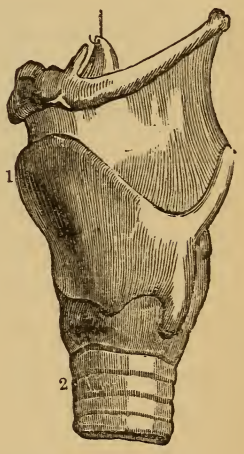

Fig. 22.
THE LARYNX. – 1. Adam's Apple. 2. Trachea.

12. The upper end of the windpipe is a kind of a box. You see it in the figure (Fig. 22), and you can feel it in your own neck. It is called "Adam's apple." Its sides are made of *cartilage*, which is almost as stiff as bone, but not so heavy. This box is the **larynx**, or *voice-box*.

13. The **vocal cords** are two elastic cords or bands, which stretch across the larynx. They can be tightened or loosened; and they can be spread wide apart, or brought together

so as to close the passage-way entirely. When we wish to make a sound, we make our breath go out quickly. As it passes between these cords, it sets them in motion, and makes a sound in the same way that sound is made in the pipe of an organ by the wind which the organ-blower pumps through it. If the cords are tight, and near together, the tone will be high. If they are loose, and wide apart, the tone will be low.

14. The larynx differs a little in shape and size in different people. The vocal cords differ in length and thickness. So voices vary, like the tones of musical instruments.

15. The muscles of the larynx grow strong by exercise, as other muscles do. By training our voices in singing and speaking, they may be made stronger and better.

16. If we wish to improve our voices, and learn to use them well, we must take pains. Those who are careless, and make no effort to speak distinctly and correctly, never can do so.

17. The *windpipe* has fifteen or twenty rings of cartilage in its wall. They are stiff, and keep the tube wide open all the time. It is directly in front of the gullet.

It divides into two tubes, which are just like itself, which go to the two lungs. Each one when

it reaches the lungs divides; and the branches divide again, and keep on dividing, until they become almost as small as hairs; and then they end

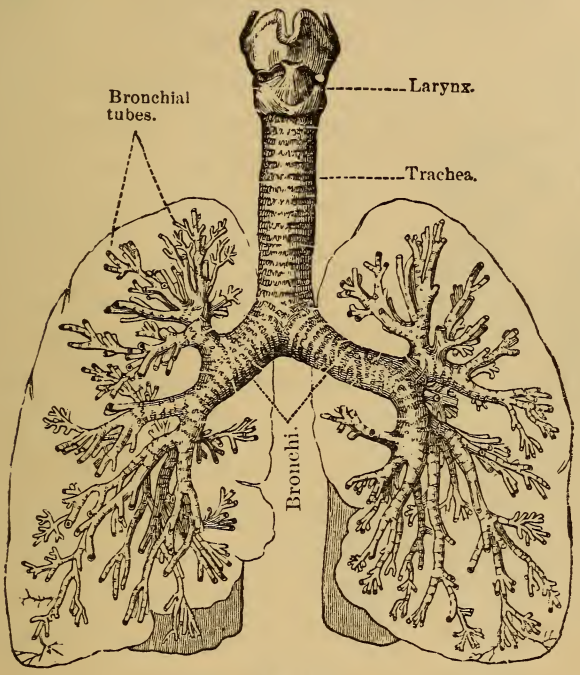

Fig. 23.

Section of the Lungs, partly showing the Course of the Bronchial Tubes.

in little bunches of air-cells. These tubes in the lungs are called **bronchial tubes.**

18. The air-tubes may be compared to a tree. The large tube which goes to the lung is the trunk. Just as the trunk divides into limbs, branches, and twigs, so the air-tube divides in the lung. The

air-cells are like the leaves in which the branches end at last.

19. But the lung is not all air-tubes and air-cells. It also contains blood-vessels. The branches of the pulmonary artery enter it by the side of the air-tube, and they divide just as the air-tube divides; and finally the little capillaries lie on the outside of the air-cells, forming a network over them. If you imagine the air-tubes to be like a tree, you can imagine the blood-vessels to be like a vine climbing the tree, and following all its limbs and branches out to the smallest twigs and the leaves.

Fig 24.

Bronchial Tubes and Air-Cells.

There are some other things in the lungs; but these two — the air-tubes and the blood-vessels — are all you need to think of at present.

20. The air tubes and cells in the lungs always contain air. By breathing, we change the air in them, and keep it fresh.

What good does that do us? Why do we want fresh air in them?

Because we want oxygen. Air is partly made of a gas called **oxygen.** Nothing can live without

oxygen. Every bit of our bodies is calling for oxygen all the time. So the blood hurries up to the lungs, and gets it, and then hurries away to distribute it, and then back again for another supply, and so on constantly. The air itself does not get into the blood, but the *oxygen* that is in the air does. The little capillaries lie on the air-cells, and the walls of both capillaries and air-cells are thin as a soap-bubble. The oxygen passes through these walls into the blood, as the nourishment passes from the alimentary canal into the blood.

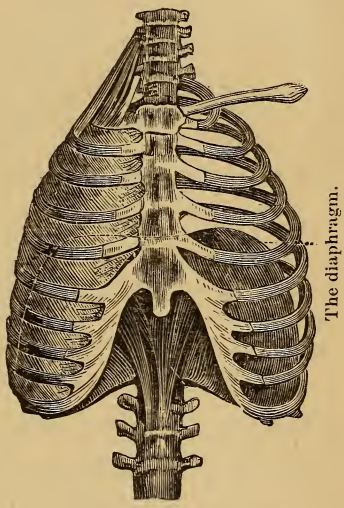

Fig. 25.
The Chest.

21. But we have not yet answered the question, How do we draw the air into the lungs? If you take hold of the handles of a pair of bellows or of an accordion, and pull them apart, the air will rush in. If you let go the handles, they will gradually come together, and the air will pour out. That is the way the air is made to go into and out of the lungs. You remember that the diaphragm is a muscle, and can move up and down. When

we take a breath, it moves down, and the sides and front of the chest swell out. The diaphragm and the walls of the chest pull the elastic lungs with them, and stretch them open. Then the air must rush in through the air-tubes, and fill them.

Down and up the diaphragm keeps moving, and the breast keeps rising and falling, and the breaths of air go in and out as the waves come and go on the beach.

22. The breath which comes out is not so pure as the breath which goes in. It has lost part of its oxygen; and it has received from the blood in exchange a gas, which we call **carbonic-acid gas.**

If many people are in a room, they will soon make all the air in it impure by their breathing. If no fresh air is let in, there will not be enough oxygen after a time to keep them alive.

23. We do not feel comfortable when we are breathing impure air. The room seems close, and we feel stifled. We may be sleepy and dull. People often suffer from these bad feelings without knowing what is the cause of them. If they would go out of doors, or open their windows, and let in the air, they would feel better.

24. Any bad smell in the air shows that there is something in it which ought not to be there. It is a sign of danger.

25. The blood in the veins has a dark purple tinge. From the right ventricle of the heart this dark blood goes through the pulmonary artery to the lungs. When it comes from the lungs through the pulmonary veins, it is bright scarlet. What has caused this change? It is the *oxygen* that is taken from the air. Besides gaining oxygen, the blood, while passing through the lungs, has lost *carbonic-acid gas.*

26. From the left side of the heart the scarlet blood is sent all through the body. When it gets into the capillaries, it grows dark again. That is because it is giving up its load of oxygen. At the same time, it takes in from the particles around the capillaries, a load of carbonic-acid gas. The oxygen is like the fuel that keeps the fire of life going, and the carbonic-acid gas is like the ashes. So the blood gives fuel, and takes up ashes, and carries them to the lungs, where they are thrown out in the breath. It is not good to breathe in a room full of ashes and smoke. Neither is it good to breathe in a room full of carbonic-acid gas from the breaths of many people.

EFFECT OF ALCOHOL AND TOBACCO.

SECT. II. — **1.** Some people think that alcoholic drinks prevent consumption. Those who try to

escape it in this way may fall into evils that are much worse.

2. When more than a small amount of alcohol is taken, it goes out of the body partly in the breath. Habitual drinkers are known by their breaths.

3. Tobacco also clings to the breath, and gives it a stale and unpleasant odor. It defiles and blackens the teeth.

4. When tobacco-smoke is drawn down into the lungs, it has a more powerful effect than when it is puffed directly out of the mouth. The nicotine which it contains passes in greater quantities through the delicate walls of the air-cells into the blood.

QUESTIONS.

SECT. I. — **1.** What three things are necessary to maintain life? Which can we spare the longest?

2. Can animals live without air? Can plants? What is the most abundant gift of God to us?

3. What is breathing?

4. What is in the chest?

5. What are the roots of the lungs made of? What is the trachea? How long is it? How wide? What does it open into?

6. What is the true breathing-passage? What are the nostrils? What does the nose open into behind?

7. What is the first reason named for breathing through the nose rather than the mouth? What is the second?

8. What is the effect of breathing through the mouth?

9. What is the cause of snoring?

10. Why do we snuff when we wish to smell keenly?

11. Why does not food go into the windpipe?

12. What is the larynx? What is Adam's apple?

13. What are the vocal cords? How is sound made?

14. What makes the difference in voices?

15. Why does the voice grow strong by exercise?

16. Can we talk or sing well without effort?

17. How is the windpipe made? What are the bronchial tubes?

18. What may the air-tubes be compared to?

19. What does the lung contain besides air-tubes? What may the blood-vessels be compared to?

20. What do the air tubes and cells contain? Why do we want to keep the air in them fresh? What is oxygen? Does air get into the blood? How does oxygen get into the blood?

21. How do we draw the air into the lungs?

22. How is our breath changed when it comes out? How is the air of a room in which are many people changed?

23. What is the effect of impure air on us?

24. What does a bad smell indicate?

25. What is the color of blood in the veins? in the arteries? Where does it change from purple to scarlet? What causes the change?

26. Where does it change from scarlet to purple? What causes the change? What may oxygen in the body be compared to? What may carbonic-acid gas be compared to?

SECT. II. — **1.** Which is worse, consumption or drunkenness?

2. What effect has alcohol on the breath?

3. What effect has tobacco on the breath? on the teeth?

4. Why is tobacco-smoke more injurious when it is breathed into the lungs?

CHAPTER IX.

THE NERVOUS SYSTEM. — THE EYE. — THE EAR.

SECT. I. — **1.** When people are tired or ill, they sometimes feel *nervous*. That means that their nerves are not in good order. Noises trouble them. They are liable to make mistakes, and can not thread a needle, or catch a ball, or do other easy things, as well as usual.

Perhaps you have sometime seen in the street a large, strong man, who could not walk any better than a baby. He reeled and staggered, and finally fell as helpless as a sack of meal. If you asked what was the matter with him, you were told that he had been *drinking*, and that the drink had affected his *brain*. His muscles were as strong as ever, but they would not hold him up because his brain was out of order.

It is evident that the **nerves** and the **brain** have a good deal to do with the action of our muscles.

It is time to inquire what the nerves and the brain are, and how they act. We shall find that they are the most important part of the body.

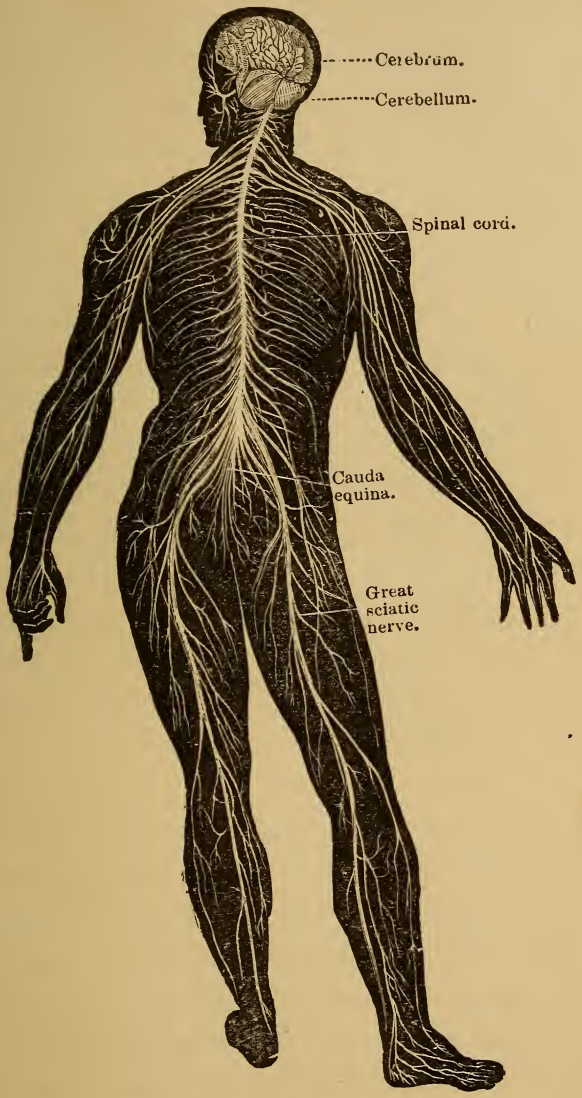

Fig. 26.

General Representation of the Nervous System.

2. You know that the brain is in the skull. If you cut through the skull of a dead animal, you can take the brain out. It is soft, part white, and part gray. The brain of an intelligent animal, like a cat or dog, is very much like the brain of a man.

But, with two exceptions,—the whale and the elephant,—no animal has as large a brain as man.

3. We know that it is in the brain that *thinking* is done, and *willing*, and *remembering*. For, if a man's brain is hurt or diseased, he partly loses the power of thinking and willing and remembering. If his muscles or his heart or his stomach are diseased, it may not affect his mind at all. Besides, experiments have been made on animals to find out what the brain does. These experiments show, that, when the brain is taken out, the animal does not know any thing. He may have the power of moving, but what mind he had is gone.

Since man can think and remember and know so much more than the lower animals, we should expect that his brain would be larger, as it is.

4. From the under part of the brain, a *cord* about as large as your little finger extends down like a Chinaman's cue. This cord lies in the center of the backbone, and is called the **spinal cord.** It is soft and cheesy, like the brain, and is part

white, and part gray, in color. The brain and the spinal cord are called the *nerve-centers.*

5. The brain and the spinal cord are both made in halves, which are exactly alike, and are joined in the middle.

6. From each half of the brain, twelve *small*

Fig. 27.

Half of the Brain, and upper end of the Spinal Cord, with the Nerves coming from them.

cords branch off; and from each half of the spinal cord, thirty-one *small cords* branch off.

These cords are the **nerves.** Those which come from the brain pass through holes in the skull to different parts of the head and neck and chest. The **olfactory** nerves lead to the nose, and are

the nerves of *smell*. The **optic** nerves lead to the eyes, and are the nerves of *sight*. The **auditory** nerves lead to the ears, and are the nerves of *hearing*. Others lead to the tongue and the skin and other parts.

7. The nerves from the spinal cord come out of the spinal canal in the backbone, and lead to all parts of the body below the head.

8. A *nerve* is a white and shining cord. The **sciatic** nerve, which is the largest in the body, is as much as half an inch wide. The smallest nerves can not be seen without a microscope.

9. If you should follow one of them from the backbone, you would find it giving off branches, and joining with other nerves, but growing smaller the farther you go. At the end it divides up into *fibers*, which reach every bit of the part it supplies. For example, suppose you start on one of the nerves from the neck-part of the spinal cord. Directly you find it joining with other nerves, and making quite a network. This network extends down into the armpit. There several branches start off, which go to different parts of the arm and hand. Follow the one which is called the **ulnar** nerve. That runs down the inner side of the arm. When it gets to the elbow, it passes just under a point of bone known

as the "funny bone." If you happen to hit this point of bone, you are very likely to bruise the ulnar nerve, and then you have a tingling sensation down to the end of your little finger. The ulnar nerve below the elbow lies just in the line of this sensation, and it ends in the little finger. If you followed it into the skin, you would have to use a microscope; and in that way you would see the network that it makes. The network is so close, that you could not prick your finger with a fine needle without hurting one of the little fibers of it.

Fig. 28.

NERVES OF THE FORE-ARM AND HAND. — 1. Artery. 2. Nerve.

Nearly every part of the body is full of these fine nerve-endings.

10. Now, if you understand how the nerves are in all parts of the body, and how they are all connected with the spinal cord or brain, we are ready to inquire what the nervous system does.

ACTION OF THE NERVOUS SYSTEM.

11. If you live in the city, you have often looked at the wires of the telegraphs and telephones over the tops of the houses, — hundreds of them running in every direction. And you know what they are for. They connect the different parts of the city; so that, if a man in his home wants to speak to the clerks in his store, he can do it, though he is a mile away. If a lady wishes to order meat for dinner, she can call the butcher without stepping outside her own door. If there is danger from burglars, a message goes along the wire, and brings a policeman. If there is a fire, it calls the engines. And so the people in the city can talk together about many things, and help each other.

12. The nervous system is in the body what the telegraph system is in the city. The nerves are like the wires, and the brain and spinal cord are like the offices.

The different parts of the body must work together, and help each other. Suppose the stomach wants food. How can it get it unless the hands pick it up, and the throat swallows it? When the stomach wants food, we feel hungry. That is the message that goes through the nerves to the

brain, "I am hungry." Then the brain sends orders out to the muscles, and they walk us to the dinner-table; and then other muscles pick up the food, and others carry it down the throat to the stomach.

Suppose some one has thrown a ball at your head. You see it coming. The message goes in along the optic nerves to the brain. The brain sends out an order to certain muscles, which raise the hands to stop it.

13. Whenever we see or hear or smell or taste or touch any thing, a message goes in over the nerve of the eye or the ear or the nose or the tongue, or the part that is touched, to the spinal cord or the brain, and the spinal cord or the brain sends out its orders along other nerves.

14. If a man breaks his back, he may not die immediately, but he will not be able to move his legs, and he will not feel it if you prick or pinch them. He is *paralyzed* below the place where his back is broken. The nerves in the legs connect with the spinal cord, and the spinal cord connects with the brain. When the back is broken, the wires are cut. There is no connection between the brain and the legs. The brain may *will* that the legs should move, but it can not send the message down. The legs may be pricked or pinched,

but the brain does not know it. The message can not go up.

15. All our feelings of hunger, thirst, heat or cold, or pain or weariness, are carried to the brain by the nerves. All our movements are made by the action of the nerves. When the nerves and brain stop acting, we no longer feel or think or move.

HEALTH OF THE NERVOUS SYSTEM.

16. Since the brain and nerves have such important work to do, we should keep them in good condition if possible.

In order that the brain may be clear, and the nerves strong, we need,—

(*1.*) Plenty of *fresh air.* You remember that we want air for the sake of the *oxygen* in it. No part of the body has such constant need of oxygen as the nervous system. The brain has a great deal of blood sent to it; and, if the blood is cut off for an instant, it will stop acting. If there is too little oxygen in the air, the brain grows dull, and the head feels uncomfortable.

(*2.*) We need plenty of *exercise.* Exercise makes us breathe faster, and makes the blood move quickly; and so the nerves and brain get more oxygen. If we have been sitting still an hour, ten minutes of running and jumping makes us feel

brighter. Children need exercise and air more than grown people.

(*3.*) We need good *plain food.* The nerves require *nourishment* as well as oxygen. If we do not have food enough, or if we spoil our digestion by eating too much candy or rich food, the nervous system will be starved and weak.

(*4.*) We need plenty of *sleep.* All day the brain and nerves are very active. They must rest at night, or they will soon wear out. A healthy person may sit up one night, or even several if he is strong; but it is torture for any one to be deprived of sleep for many days. This is because, while we are awake, the brain and nerves are wearing out a little faster than they are being repaired. In the night they are repairing faster than they are wearing, and by morning they are as good as they were the morning before.

A baby a few days old sleeps almost all the time. As he grows older, he sleeps less. Children need much more sleep than grown people. Their nervous systems are more delicate, and wear faster. Besides, they are growing, and ought to be a little larger and stronger every morning.

Sitting up late at night makes pale faces and weak limbs and irritable nerves.

(*5.*) We need *change of occupation.* Change is

rest. If we have been studying, it rests us to run. If we have been playing hard, it rests us to sit down with a book. It is not wise for a child to read too long at one time. Out of school he should be playing, or working in some other way.

THE EYE.

SECT. II. — **1.** The eyes are placed in two cavities called the **orbits**. The **eyeball** is a sphere about an inch in diameter. It does not fill the orbit. There is considerable space around it and behind it, which is padded with fatty tissue. This makes a cushion for it to rest on. The *eyelids*, with their long *lashes*, are to protect the eye. The *eyebrows* are a kind of awning, which keeps off the perspiration that might trickle down from the forehead.

2. In the orbit, just over the eyeball, is the **lachrymal gland**. This is a gland of about the size and shape of an almond. It is filled with blood-vessels, and makes *tears* in the same way in which the sweat-glands make perspiration. The water comes out of it by little tubes, and flows over the surface of the eye. Ordinarily there is just enough to keep the eye moist and smooth.

3. At the inner end of the edge of each eyelid is a hole as large as the point of a pin. You can

easily find it on the lower eyelid. These holes are the beginnings of little canals that carry off the water. The canal from the upper, and that from the lower lid, come together in a sac in the inner corner of the orbit, which is called the **lachrymal sac.** From the lachrymal sac a canal called the **nasal duct** runs straight down into the nose. Ordinarily the water can easily flow off through these canals. We do not notice it in the nose. But when we feel badly, or when a cold wind blows in our faces, or when we get dust in our eyes, the lachrymal glands are very active. The water runs into our noses so rapidly that we have to use a pocket-handkerchief; and, besides, it runs over on our cheeks, making tears. The first thing you do, when you cry, is to put your knuckles to your eyes to rub the tears out.

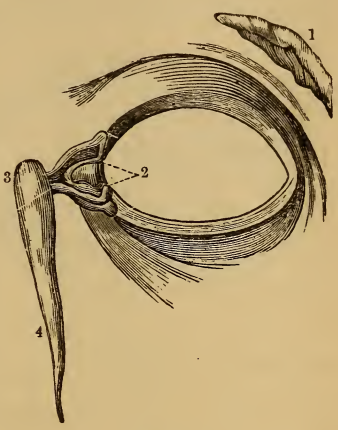

Fig. 29.
LACHRYMAL APPARATUS.—1. Lachrymal gland. 2. Tear-passages. 3. Lachrymal sac. 4. Nasal duct.

4. We see only the front of the eyeball when it is in its place. In the center is a round black hole. This is the **pupil.** The colored part, which may be black or brown or blue or gray, is the **iris.**

You notice that the pupil is large when the eye is in the shade, and small when it is in a strong light. That is because the iris, which is made in part of muscle-fibers, changes its shape. It is a curtain with a hole in it, and its use is to protect the inside of the eye from too much light.

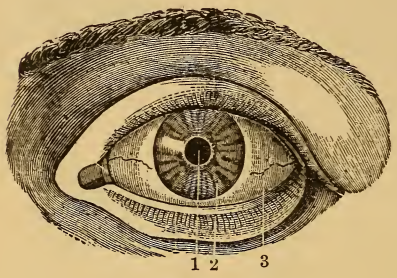

Fig. 30.

THE EYE.—1. Pupil. 2. Iris. 3. Sclerotic Coat.

5. If you look from the side at the front of an eye, you will see, that, before the iris, there is a transparent cover, which is like a watch-glass in shape. This is the **cronea.** All around the cornea is the *white of the eye.* The white is the outside coat which covers the whole of the ball except the part where the cornea is. It is called the **sclerotic** coat.

6. Get an ox-eye from the butcher's, and examine it. You will see all these things on the front. Attached to the sides, you may find, if it has not been trimmed off carefully, several slips of red muscle. These are the muscles which move the ball, and roll it in every direction. At the back part, you will find a firm white stem, like the stem of a grape. This is the **optic nerve,** which has been cut off in taking the eye out. It comes from

the brain, through a hole in the back part of the orbit, and passes through the coats of the ball, and then spreads out, and makes a lining for these coats. This lining is called the **retina**.

7. Now, cut through the ball. It is filled with *fluid*. The ball collapses as a grape would if you

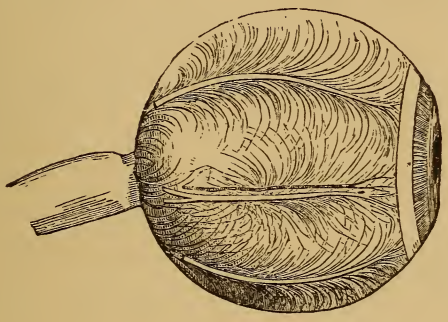

Fig. 31.

Eyeball and Optic Nerve.

should cut it open. If you are careful, you will find in it a hard, transparent body shaped like a small button. This is the **lens**.

8. Now you have seen the principal parts of the eyeball. They are, —

The sclerotic coat.	The retina.
The cornea.	The fluid contents.
The iris.	The lens.

The parts outside the ball are, —

The eyebrows.	The lachrymal gland.
The eyelids.	The lachrymal sac.
The eyelashes.	The nasal duct.
The muscles.	The optic nerve.

9. The eyeball is like the box that the photographer uses in taking your picture. In the front part of his box there is a lens, as there is in the eyeball. In the back part there is a plate, which is like the retina; and on this the picture is made. When you look at an object, a picture of it is made on the retina. The retina is the end of the optic nerve. The impression which makes the picture is carried by the optic nerve into the brain. It is really the brain which sees, not the eye. The eye is the instrument.

10. Good eyes do not often get tired, and they see distinctly both far and near objects. Old persons can not see things near their eyes so distinctly as they can see things at a distance. Glasses help them to read. Some young persons can not see, distinctly, things a little way off, though they can see perfectly any thing very near their eyes. We call them *near-sighted.* They sometimes have to wear glasses.

CARE OF THE EYES.

11. If we do not wish to become near-sighted,

or to have weak eyes, we should observe the following rules: —

(*1.*) Do not hold your book too near to your eyes.

(*2.*) Do not hang your head over your book.

(*3.*) Do not read when lying down.

(*4.*) Do not read when the light is growing dim. Lay down your book until lamps are brought.

(*5.*) Stop reading when your eyes smart or feel tired.

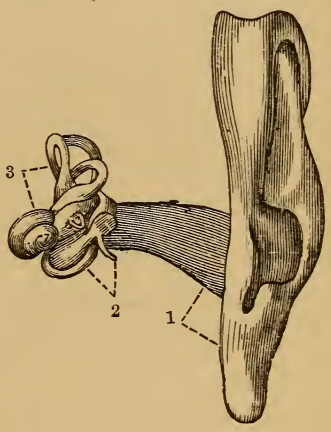

Fig. 32.

THE EAR. — 1. Parts of the external ear. 2. Parts of the middle ear. 3. Parts of the internal ear.

THE EAR.

SECT. III. — **1.** You know very well that the ear is not all on the outside of the head. The part which you see is the **external ear.** It is the end of a tube, which catches the sounds, and carries them into the head. This tube is an inch long. At the bottom of it is the **tympanum,** or *drum-head.*

2. The **middle ear,** or *drum,* is behind the tympanum. It is a small cavity, which contains the little bones of the ear. It is connected with the throat by a tube called the **Eustachian tube.**

3. The **internal ear** is still farther in. It is in this part of the ear that the nerves of hearing are. The external and middle ear carry the sound in. The internal ear receives it, and the impression is carried from there in to the brain.

EFFECTS OF ALCOHOL AND TOBACCO.

SECT. IV. — **1.** When men take a little liquor, it makes them feel comfortable or gay. The brain and nerves are stimulated. If they take enough to get slightly intoxicated, they become talkative and boastful, or cross or silly. If they drink more, they lose their judgment. Their passions become violent. They are ready to be excited by small things, and to quarrel. Many of the murders and other crimes, of which we read every day in the papers, are done under the influence of alcohol. Men who when sober are quiet and kind, are changed by it into wild beasts. After the drunken fury is past, they are filled with remorse for what they have done. The brain ought to be the master of the whole body. In such men it becomes a slave. When the appetite sends in through the nerves a demand for liquor, it can not refuse.

2. The man who indulges freely in drink is likely to pay for it the next day. His head aches. He is low-spirited and weak. His stomach is foul.

His appetite is gone. He then thinks that he never will take it again. But, when the nerves are accustomed to the excitement of drinking, they will not give it up easily.

3. *Delirium tremens* is one of the results of the free use of alcohol. This is a disease of the nervous system. The victim of it is wild and raving. He is filled with distress and horror. Death sometimes ends his misery. If he recovers, he is likely to have it again if he continues drinking.

4. *Insanity* is another result of drinking-habits. Many of the patients in insane-asylums are brought there by drink.

5. Discord in families, quarrels, murders, sickness, pauperism, insanity, and misery are some of the results of the action of alcohol on the nervous system.

Do not understand that alcohol always produces such results. Men sometimes use it through a long life without seeming to be harmed by it. But its victims are in every community, and among all classes of the people.

6. *Tobacco* acts on the nervous system chiefly. At first it makes the head giddy, and the whole body faint and sick. Afterwards it gives pleasure. An unsteady hand, a languid brain, and an irregular heart, often follow its use. Many men are

wearing out their nerves, and shortening their lives, by tobacco. Many boys are making their bodies puny, and their minds weak, by tobacco.

Cigarettes are said to have a worse effect on the nervous system than cigars. Sometimes they are made of the stumps of cigars, which contain more nicotine than other tobacco; and their smoke is more likely to be drawn into the lungs.

7. Opium and chloral are used for their effects on the nervous system. Their habitual use tends to destroy the will-power and the conscience, and ruin the mind altogether.

QUESTIONS.

SECT. I. — **1.** What is it to feel nervous?

Why does a drunken man fall?

2, 3. Where is the brain? Of what color is it? What animals have the largest brains? Where are thinking, willing, and remembering done? How do you know? Why should we expect man's brain to be larger than the brains of lower animals?

4–7. What is the spinal cord? Where is it? What are the nerve-centers? What are the nerves? With what are they all connected? Where is the olfactory nerve? the optic nerve? the auditory nerve? Where do the nerves from the spinal cord go?

8. How large is the largest nerve? the smallest?

9. Describe the course of a nerve starting from the backbone. Why does your little finger tingle when you strike your "funny-bone?"

11–15. What are telegraph-wires for? How does the nervous system resemble the telegraph? Give illustrations. What happens

when we see or hear or smell or taste or touch any thing? What is it to be paralyzed? Could we feel or move without the brain and nerves?

16. Why is fresh air needful for the brain? Why is muscular exercise needful for the brain? What happens to the brain and nerves if we do not have food enough, or if we spoil our digestion?

Why is sleep needful for the brain and nerves?

Why do children need more sleep than grown people? Why is change of occupation needful for the brain and nerves?

SECT. II. — **1-11.** What is the cavity in which the eye is situated called? What is the lachrymal gland? What is its use? Where is the lachrymal sac? Where is the nasal duct? What makes tears? What is the pupil of the eye? What is the iris? What is its use? What is the cornea? What is the sclerotic coat? What do the muscles of the eye do? Where does the optic nerve enter the eye? What is the retina? What is contained in the eyeball? Name the principal parts of the eyeball. Name the principal parts of the eye outside of the eyeball. What instrument is the eyeball like? For what do old persons need glasses? What is it to be "near-sighted"? Give some rules for the care of the eyes.

SECT. III. — **1-3.** What do you call that part of the ear which is on the outside of the head? Where is the Eustachian tube? What is in the internal ear?

SECT. IV. — **1.** What is the effect of a small amount of alcohol on the nervous system? What is the effect of a larger amount? How does alcohol enslave the brain?

2-4. What is often the effect of the free use of alcohol on the nervous system the day after taking it? What diseases of the nervous system result from the use of alcohol?

5. What other results of the action of alcohol on the nervous system? Do these results always follow?

6, 7. What effect does tobacco often have on the nervous system? Are cigarettes less harmful than cigars? What is a common effect of the habitual use of opium and chloral?

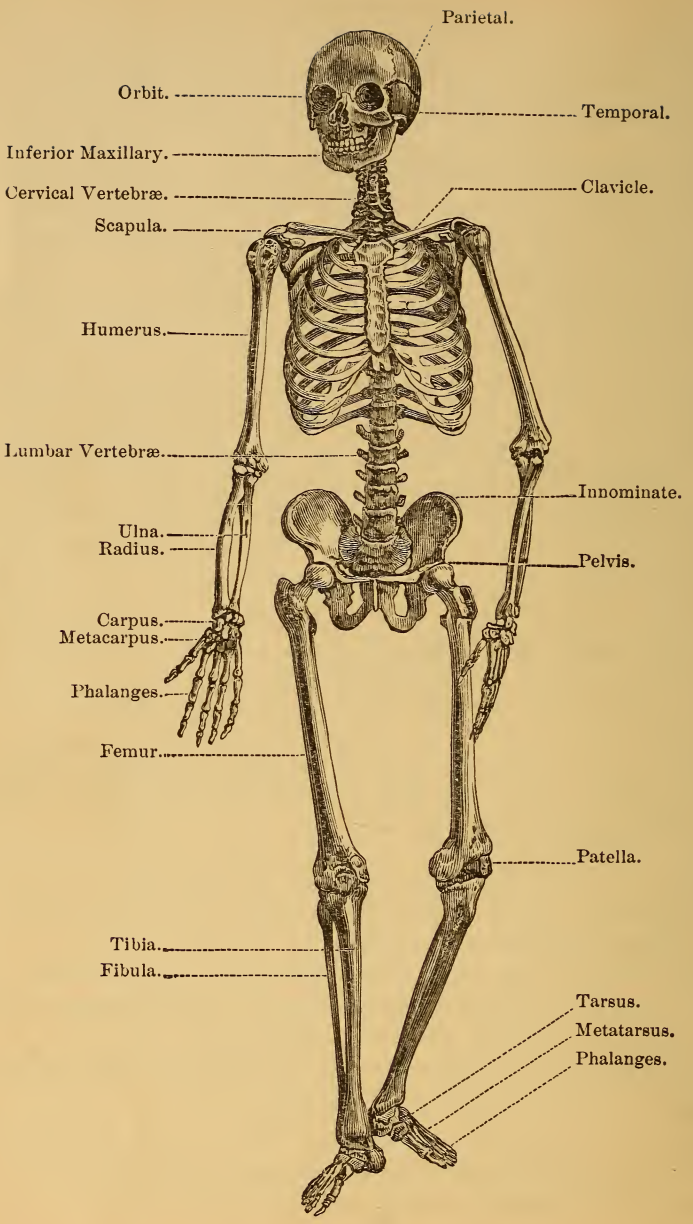
Parietal.
Orbit.
Temporal.
Inferior Maxillary.
Cervical Vertebræ.
Clavicle.
Scapula.
Humerus.
Lumbar Vertebræ.
Innominate.
Ulna.
Radius.
Pelvis.
Carpus.
Metacarpus.
Phalanges.
Femur.
Patella.
Tibia.
Fibula.
Tarsus.
Metatarsus.
Phalanges.

Fig. 33.

CHAPTER X.

THE FRAMEWORK.

SECT. I. — **1.** Thus far we have been studying the soft parts of the body. When they are taken away, the *bony frame* remains.

A skeleton is a ghastly object. But, if you had no bones under your flesh, you could not walk, or even stand. The skeleton protects the brain and the spinal cord, and the heart and lungs, and other parts, in its cavities.

2. Man and the quadrupeds, and birds and fishes, are all alike in this: they all have bony frames, and all have *backbones.* The backbone is made up of small bones called **vertebræ**; and man, and all animals with a backbone, are

Fig. 34.

The Backbone sawed in two, lengthwise.

called *vertebrates*. Their bony frames are a good deal alike too. The skeleton of a cat has the same parts as that of a man. Her fore-legs correspond to his arms. Her backbone is lengthened out in a tail. Her claws correspond to his finger-nails.

3. A child has many more bones than a man, because some bones that were at first separate grow together as he gets older. A man has two hundred bones.

4. Some of the bones of the skull are flat. The ribs are flat and curved. The hip-bones are very irregular in shape. The bones of the limbs are long and rodlike.

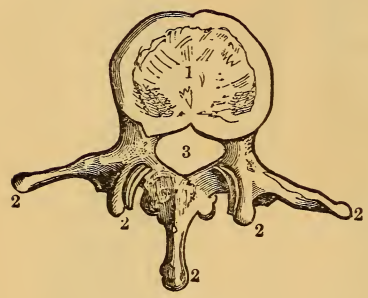

Fig. 35.
A VERTEBRA.—1. Body. 2. Processes. 3. Spinal canal.

5. The *vertebræ* which make up the backbone are bound together by strong ligaments. They move a little on each other; and so the backbone can be bent and twisted in every direction, and serves us much better than it would if it were all one stiff bone. In every vertebra there is a large hole. When they are joined together, these holes make a canal in the center of the backbone, which is called the

spinal canal. The top vertebra fits around a hole in the bottom of the skull. Through this hole, the spinal canal connects with the cavity of the skull.

The top vertebra is called the **atlas.** You can easily find the reason for this name by inquiring of your teacher.

6. The spinal cord is well protected by the *backbone*, and the brain is well protected by the *skull.*

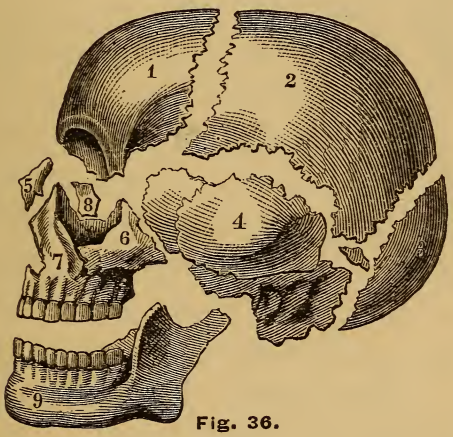

Fig. 36.

THE SKULL. — 1. Frontal bone. 2. Parietal bone. 3. Occipital bone. 4. Temporal bone. 5. Nasal bone. 6. Malar bone. 7. Superior maxillary bone. 8. Lachrymal bone. 9. Inferior maxillary bone.

The only openings in the skull are the large one which connects its cavity with the spinal canal, and the small ones which let the nerves through.

7. The **ribs** are twelve in number on each side. The first seven of these are connected with the

backbone behind and the **breast-bone** in front.* These are called *true ribs.* Five are not connected with the breast-bone. They are called *false ribs.*

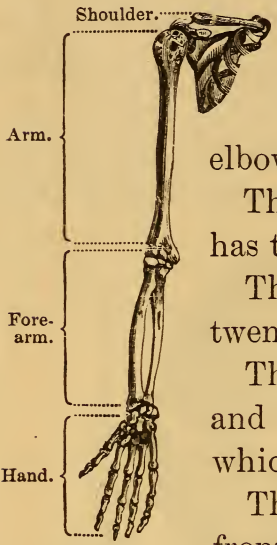

Fig. 37.
The Upper Limb.

The **collar-bone** and the **shoulder-blade** form the *shoulder.*

The *arm* (from shoulder to elbow) has one bone.

The *fore-arm* (from elbow to hand) has two bones.

The *hand* (including the *wrist*) has twenty-seven bones.

The two *hip-bones* are very large and strong. The *thigh* has one bone, which is the largest in the body.

The *knee-cap* is a small bone in front of the knee.

The *leg* (from knee to foot) has two bones.

The *foot* has twenty-six bones.

JOINTS.

Sect. II.—**1.** All these bones are connected by joints. Some of them are called *hinge-joints,* because they allow movement in two directions, like a hinge. The elbow-joint is a hinge-joint. Others

* For representation of the Thorax, see Fig. 25.

are called *gliding joints*, because the bones glide on each other in various directions. The wrist-joint is a gliding joint. The shoulder and the hip joints are called *ball-and-socket joints*. They allow motion in every direction, and are the freest of all the joints.

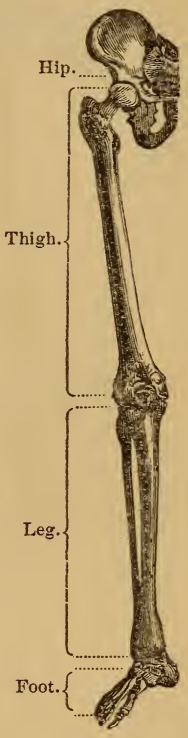

Fig. 38.
The Lower Limb.

In a movable joint, the bones are covered with **cartilage** (gristle). Cartilage is smooth, and more elastic than bone. It makes the joints springy.

Most of the joints in the skull are tight and immovable.

2. In every machine, the joints have to be carefully watched, and greased often, or else they will get dry, and creak and wear. Our joints grease themselves. They have a lining, that keeps giving out from its surface a fluid like the white of an egg. This fluid is called **synovia**, or *joint-water*. Unless we have rheumatism, or some other disease of the joints, they are kept always smooth, and in good working-order, in this way.

3. The bones are held together at the joints by

bands of strong, tough substance that does not stretch. These bands are called **ligaments,** and they surround the ends of the bones. Sometimes a bone gets such a twist that the end of it breaks through the ligaments, and gets *out of joint.* Then it must be carefully put in place.

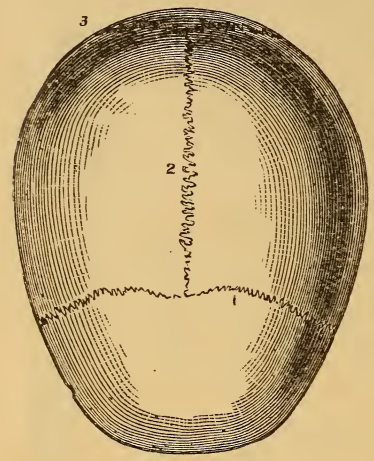

Fig. 39.

JOINTS OF THE SKULL. — 1. Frontal bone. 2. Parietal bone. 3. Occipital bone.

STRUCTURE OF BONE.

SECT. III. — **1.** Bones that have been thoroughly dried, or that have been cooked, are white. But a bone in a living person is pink in color. It is full of blood-vessels, and has nerves too. It is made partly of phosphate of lime, which is a mineral just like some rocks. That is what gives it its hardness. Children's bones are not so brittle as those of grown people. They will bend a good deal without breaking. The bones of old people are sometimes very brittle.

2. The long bones are not solid, but have a canal in their centers. This is filled with *marrow.*

If you cut through a flat bone, you will find that it is hard outside, but inside it is full of holes, which give it a kind of honeycombed appearance.

3. When a bone is broken, it has to be "set." In setting bones, the broken ends must be fitted together. Bandages, and strips of wood, or some stiff substance, must be put around them, to keep them in place. Then Nature joins them so that they are just as strong as before.

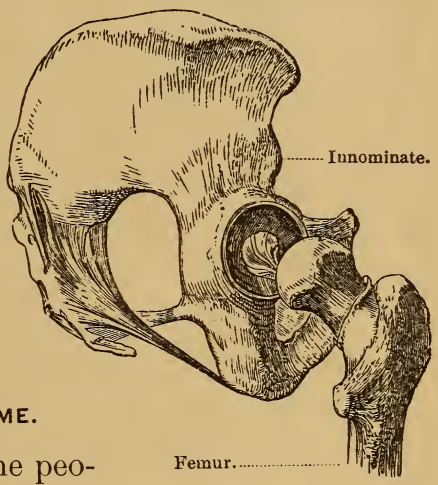

Fig. 40.
The Hip-Joint.

CARE OF THE FRAME.

SECT. IV. — **1.** Some people have better forms than others. The form depends chiefly on the bony frame. A straight back and neck, and a full chest, a waist of natural size, and straight limbs, make a good figure. The shape we shall have when we are grown depends very much on our habits while we are children.

2. If we sit or stand with our shoulders for-

ward, and our backs curved, we shall be likely to have curved backs and stooping shoulders always. If we hold up our heads and shoulders, our backs will grow straight.

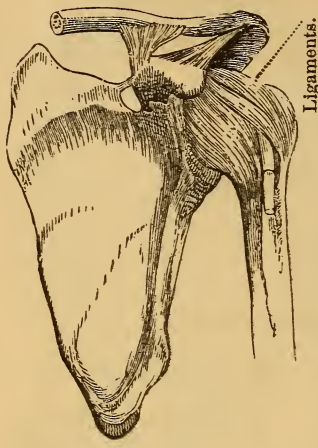

Fig. 41.
The Shoulder-Joint.

3. The part of our frames which is most frequently misshapen is the foot. We can change the shape of the foot very much by the shoes we wear. The great toe is naturally almost in line with the inner side of the foot, and the other toes are spread out so as to have plenty of room. But the great toe of most grown people turns in toward the other toes, and the toes overlap each other. Short and narrow shoes, and high heels, have caused this. The swelling on the great-toe joint, which is called a *bunion*, is made in the same way.

4. Tight and high-heeled shoes check the natural elastic movements of the foot, and deform it.

Clothes which bind the waist and chest hinder breathing, and squeeze the inward parts out of place.

The frame should be free in every part to take

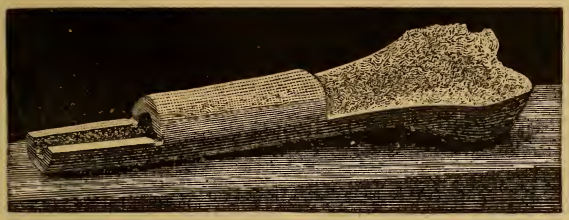

Fig. 42.

Section of the Thigh-bone.

the shape which Nature intended for it. Active exercise of the muscles helps it to do so.

EFFECTS OF ALCOHOL AND TOBACCO.

SECT. V. — **1.** The bones are alive as truly as are the soft parts of the body. The blood runs through them constantly. They depend on it for their nourishment and health. When the blood is poisoned with alcohol and tobacco, and the rest of the system is suffering, the bones must suffer too.

2. There is good reason for believing that boys frequently *check the growth* of their bony frames by the use of alcohol and tobacco.

QUESTIONS.

SECT. I. — **1.** Of what use is the bony frame in the body?

2. What is a vertebra? What is a vertebrate? What animals, with which you are familiar, are vertebrates?

3, 4. Who has the largest number of bones, — a child or a man? How many bones has a man? What are the shapes of the bones?

5. What makes the backbone flexible? What makes the spinal canal? How does the spinal canal connect with the cavity of the skull? Why is the top vertebra called the atlas?

6. How is the spinal cord protected? The brain?

7. How many ribs are there? Which are the true ribs? Which are the false ribs? With what are the true ribs connected? With what are the false ribs connected? What bones form the shoulder? How many bones in the arm? How many bones in the fore-arm? How many bones in the hand? How many bones in the thigh? What is the knee-cap? How many bones in the leg? in the foot?

SECT. II. — **1.** How are the bones connected? Name three kinds of joints, and mention one of each kind. What joints allow the freest motion? What covers the bones, in a movable joint? What is the use of this covering? Are all the joints movable?

2. How are our joints kept smooth? Do they ever get rough?

3. What holds the bones together at the joints?

SECT. III. — **1.** What is the color of bone? Has bone any blood-vessels? What makes bones so hard? What difference is there between the bones of children and grown people?

2, 3. Are the long bones solid? What is in them? Are the flat bones solid? Why not? What must be done with a broken bone? What does Nature do with it?

SECT. IV. — **1-3.** What gives shape to the human form? What do we mean by a good figure? How may our figures be made better or worse? What part of our frames is most often misshapen? How is it made so? What is a bunion?

4. What is the effect of tight and high-heeled shoes? What is the effect of tight clothing about the waist and chest? What helps the frame to take a good and natural shape?

SECT. V. — **1.** How may alcohol and tobacco affect the bones?

2. How may they affect the size of the body?

GLOSSARY AND INDEX.

GLOSSARY.

Al'i-mĕnt. Nourishment.

A-năt'o-my. The science of the structure of organized bodies.

A-or'ta. The great artery which comes from the heart, and passes down by the backbone.

Au'ri-cle. A name given to two cavities of the heart.

Bī'ceps. A muscle on the front of the arm.

Căp'il-la-ry. A hairlike tube.

Ca-rŏt'id. A name applied to several arteries in the neck.

Cor'ne-a. The circular, transparent membrane in front of the eye.

Cor'pus-cle. A minute particle.

Cū'ti-cle. The upper layer of the skin.

Cū'tis. The deep layer of the skin.

Dăn'druff. A scurf which forms on the scalp, and comes off in small scales.

Dī'a-phrăgm. A sheet made of muscle and fibrous membrane, between the chest and abdomen.

En-ăm'el. The hard and polished substance which covers the crown of a tooth.

Găs'tric. Pertaining to the stomach.

Glănd. A name given to many organs which take part in the processes of life.

Hy'giēne. The science of health.

I'ris. A colored muscular membrane in the anterior chamber of the eye.

Lăch'ry-mal. Pertaining to tears.

Lymph. Contents of the lymphatic vessels.

Mī'tral. Like a miter, or bishop's cap.

Nar-cŏt'ic. That which soothes or stupefies.

Œ-sŏph'a-gus. The gullet.

Păn'cre-as. An organ of digestion. The sweetbread in calves.

Phys-i-ŏl'o-gy. The science of the functions of organized bodies.

Plăs'ma. The watery part of the blood.

Plĕx'us. A network of vessels, nerves, or fibers.

Pōre. The outlet of a sweat duct or gland.

Pŭl'mo-na-ry. Pertaining to the lungs.

Pū'pil. The central opening in the iris.

Py-lō'rus. A muscular ring which surrounds the outlet of the stomach.

Rĕs-pi-rā'tion. The process of breathing.

Rĕt'i-na. The terminal fibers of the optic nerve, lining the back part of the eye.

Sa-lī'va. Spittle.

Sar-tō'ri-ŭs. A muscle extending

from the hip to the leg, on the front of the thigh.

Scle-rŏt'ic. A term applied to the outer coat of the eye.

Se-bā'ceoŭs. Fatty, or tallowy.

Sĕm-i-lū'nar. Shaped like a half-moon.

Sta-pē'di-us. A very small muscle in the drum of the ear.

Stĭm'u-lant. That which goads or excites.

Syn-ō'via. Joint-water.

Tĕn'don. A cord of white, fibrous tissue connected with a muscle.

Tĕn'don of A-chĭl'lēs. The tendon of the gastrocnemius and soleus muscles inserted in the heel. It was fabled that this was the only part in which Achilles was vulnerable.

Thō'rax. The chest.

Trĭ-chī'na. A small worm that lives in the muscles of pigs, and of some other animals, and of men.

Tri-cŭs'pid. Three-pointed.

Vĕn'tri-cle. A name given to several small cavities in the body.

Ver'te-bra. One of the bones which make the backbone.

Vō'cal cords. Two fibrous bands that form the margins of the glottis, or upper part of the larynx.

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